



NJ Department of Environmental Protection

Water Monitoring and Standards

**Sanitary Survey Report of Shellfish Classification
for Growing Area DB1
The Delaware Bay from Maurice River Cove
to Artificial Island**



January 2017

State of New Jersey

Chris Christie, Governor

Kim Guadagno, Lt. Governor

NJ Department of Environmental Protection

Bob Martin, Commissioner

**Sanitary Survey Report of Shellfish Classification
for Growing Area DB1
The Delaware Bay from Maurice River Cove
to Artificial Island**

New Jersey Department of Environmental Protection
Water Resources Management
Daniel Kennedy, Assistant Commissioner

Water Monitoring and Standards
Bruce Friedman, Director

Bureau of Marine Water Monitoring
Bob Schuster, Interim Bureau Chief

January 2011 to February 2017

Report prepared by:

Paul Wesighan

Acknowledgements:

This report was written and published under the direction of Bob Schuster, Interim Bureau Chief. Mike Kusmiesz, Julie Nguyen, and Scott Chernoff assisted in the collection and storage of statistical and GIS data used in analysis. Special acknowledgment is given to Captain Marc Resciniti for perseverance in collecting shellfish water quality samples. This study would not have been completed without the aid of the analytical capabilities of our microbiology laboratory staff, including Elena Heller, Robert Seabrook, Carrie Lloyd and Abolade Oyelade (advanced microbiology lab); and our chemistry laboratory staff, including Bill Heddendorf (interim supervisor – microbiology and chemistry labs), Eric Ernst, and Dawn Thompson, with overall supervision by Bob Schuster, Interim Bureau Chief.

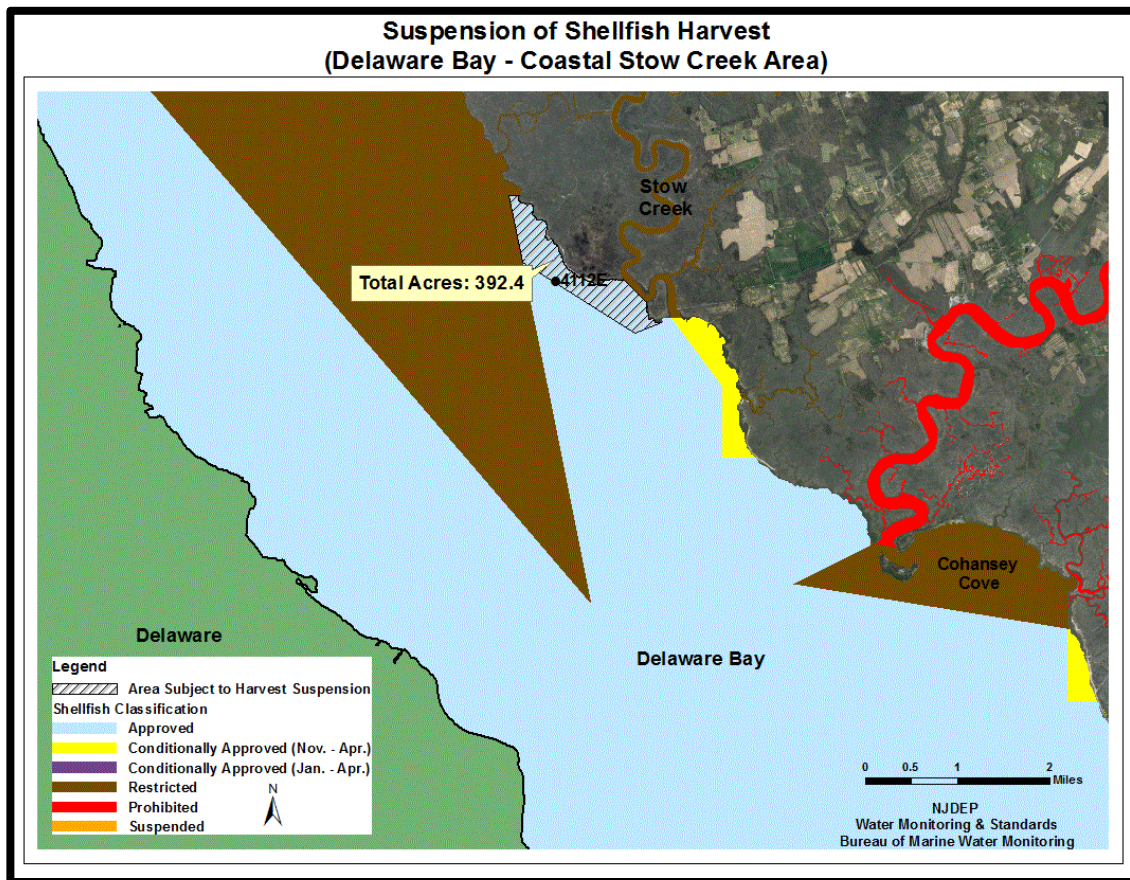
Cover Photo – Outfall pipe for the Millville City Sewage Authority Wastewater Treatment Facility discharging into the Maurice River at the end of Fowser Road in Millville.

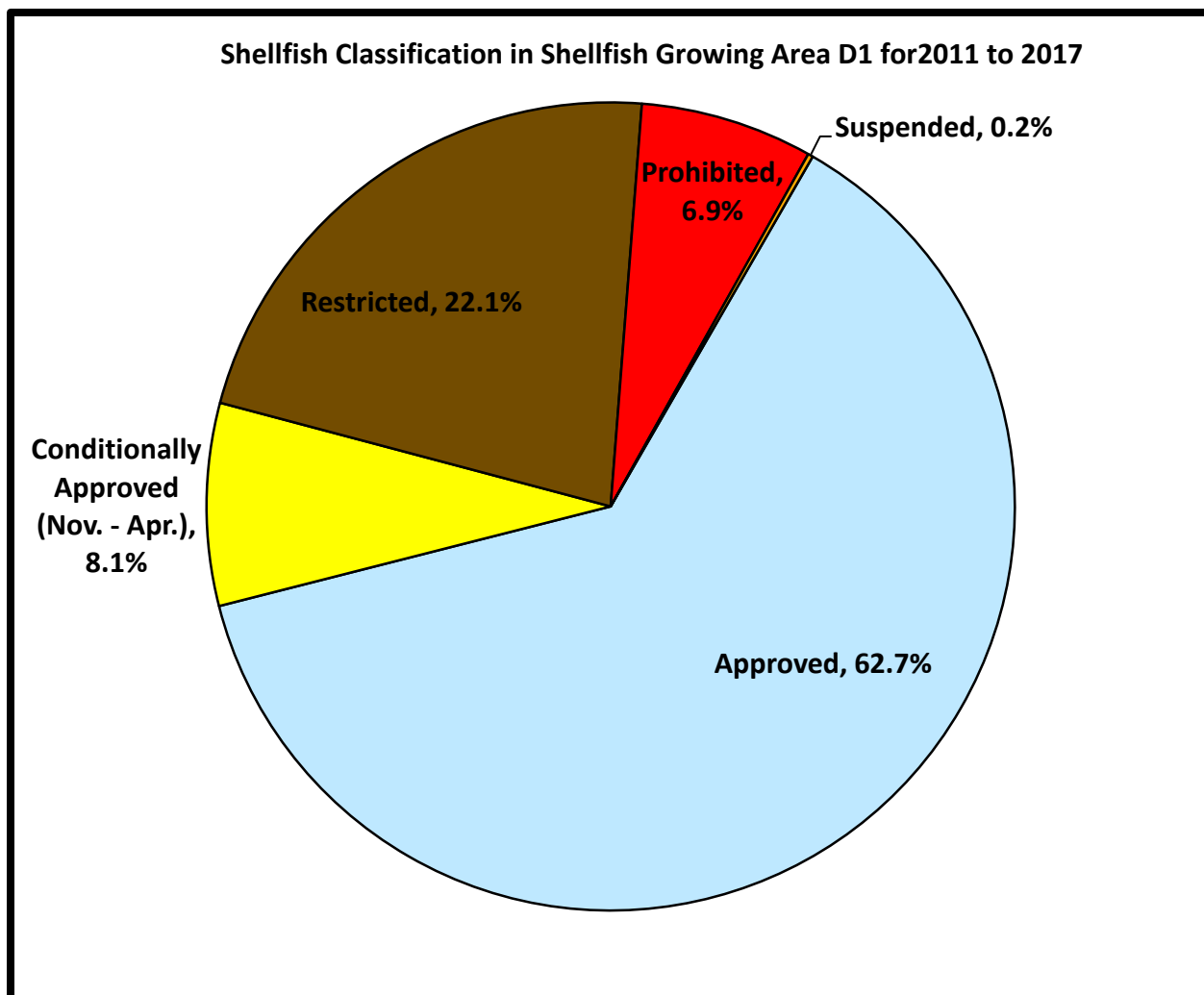
TABLE OF CONTENT

EXECUTIVE SUMMARY	1
DESCRIPTION OF GROWING AREA	2
Location & Description.....	2
Growing Area Classification.....	5
Evaluation of Biological Resources.....	8
SHORELINE SURVEY: EVALUATION OF POTENTIAL POLLUTION SOURCES.....	11
Shoreline Survey	11
Land Use	13
<i>Known Contaminated Sites</i>	14
Direct Discharges.....	16
Surface Water Discharges.....	19
Marinas	20
Groundwater Discharges.....	24
Spills, Unpermitted Discharges, and Closures.....	25
Naturally Occurring Pathogens.....	33
Stormwater Discharges	37
WATER QUALITIES STUDIES.....	38
Sampling Strategy	38
Bacteriological Quality	40
<i>Compliance with NSSP APC Criteria</i>	40
<i>Seasonal Effects</i>	40
<i>Rainfall Effects</i>	42
RELATED STUDIES	44
Nutrients.....	44
Toxic Monitoring.....	46
CONCLUSIONS	47
RECOMMENDATIONS.....	47
LEGAL DESCRIPTION FOR RECOMMENDED CHANGES:	47
LITERATURE CITED	49
SUPPORTING DOCUMENTATION	51

EXECUTIVE SUMMARY

Shellfish Growing Area DB1: The Delaware Bay from Maurice River Cove to Artificial Island, is a shellfish growing area located in the southwestern part of New Jersey, and this growing area borders the shoreline of the Delaware Bay from Maurice River Cove in Maurice River Township, Cumberland County, and extends northwest to Artificial Island in Lower Alloway Creek, Salem County. Waters within this shellfish growing area are currently classified as *Approved* (62.7%), *Conditionally Approved (November to April)* (8.1%), *Restricted* (22.1%), *Prohibited* (6.9%), and *Suspended* (0.2%) and the approximate size of this shellfish growing area is 85,774.0 acres. The water quality data presented in this Reappraisal of Shellfish Growing Area DB1, the Delaware Bay from Maurice River Cove to Artificial Island, were collected between January 2011 and February 2017. This shellfish growing area is sampled using the Adverse Pollution Condition (APC) strategy. The water quality of this shellfish growing area continues to be good and most of the sampling stations meet their current classifications. However, bacteria levels at APC sampling station **4112E**, located in the Delaware Bay along the coastal Stow Creek area, no longer meet criteria established by the NSSP for the *Approved* classification. Therefore, approximately 392.4 acres of *Approved* shellfish waters around sampling station **4112E** will need to be downgraded to the *Restricted* shellfish classification.





DESCRIPTION OF GROWING AREA

Location & Description

Shellfish Growing Area DB1: The Delaware Bay from Maurice River Cove to Artificial Island, is a shellfish growing area located in the southwestern part of New Jersey (see figures on page 4). This shellfish growing area borders the shoreline of the Delaware Bay from the Maurice River Cove in Maurice River Township, Cumberland County, and extends northwest to Artificial Island in Lower Alloways Creek Township, Salem County. The southeastern edge of this shellfish growing area is located south of East Point, which is east of the mouth of the Maurice River at the border between this shellfish growing area and Shellfish Growing Area DB2 (The Delaware Bay – Cape Shore Area). The northwestern edge of this shellfish growing area is located at the border between New Jersey and Delaware, which is on a line extending from a point about 7.5 miles west of Egg Island Point and going southeast to a point about 7.3 miles west of Cape May Point. The southwestern

edge of this shellfish growing area is located at the border between this growing area and Shellfish Growing Area DB3 (The Delaware Bay Offshore – Cross Ledge, Deadmans & Brandywine Shoal). This shellfish growing area also includes Hope Creek, Stow Creek, the Cohansey River, Back Creek, Cedar Creek, Nantuxent Creek, Dividing Creek, the Maurice River, and smaller tidal tributaries.

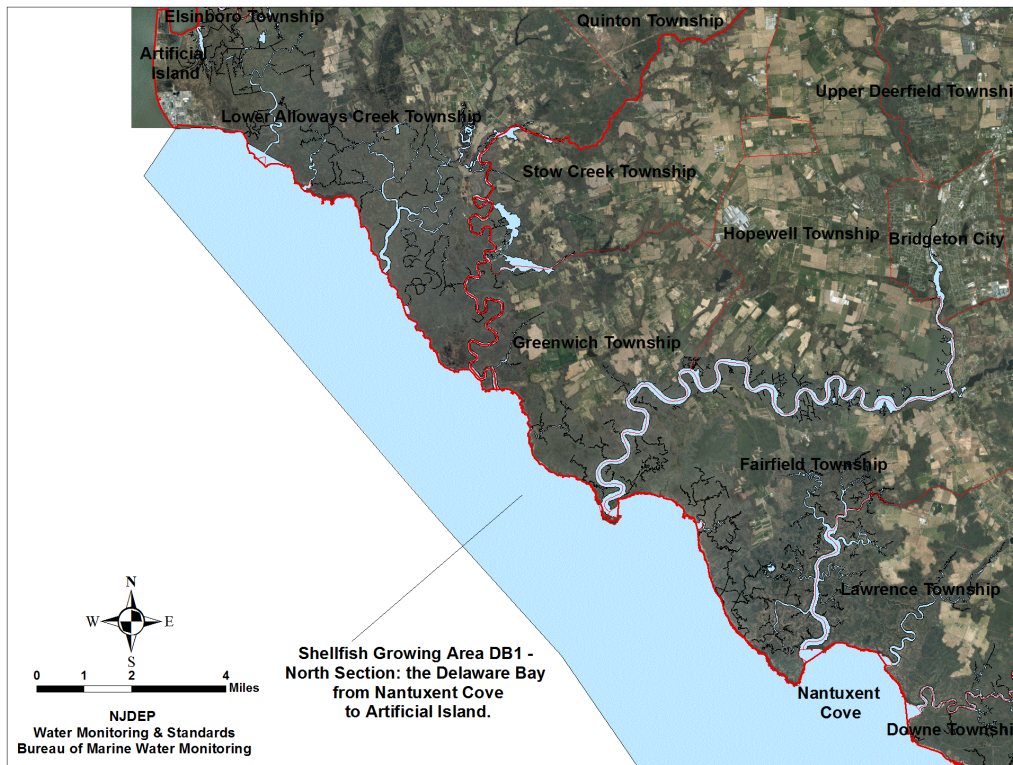
The municipalities on the shore of this shellfish growing area include Maurice River Township, Commercial Township, Millville City, Downe Township, Lawrence Township, Fairfield Township, Hopewell Township, and Greenwich Township in Cumberland County; and Lower Alloways Creek Township in Salem County. The locations of these adjacent municipalities are shown in the figures on page 4.

The approximate size of this shellfish growing area is 85,774 acres, and the shellfish classification for this growing area is *Approved*, *Conditionally Approved (November to April)*, *Restricted*, *Prohibited*, and *Suspended* for shellfish harvesting. There are approximately 53,771.5 acres of *Approved* waters, 6,926.2 acres of *Conditionally Approved (November to April)* waters, 18,952.3 acres of *Restricted* waters, 5,960.7 acres of *Prohibited* waters, and 163.3 acres of *Suspended* waters in this shellfish growing area.

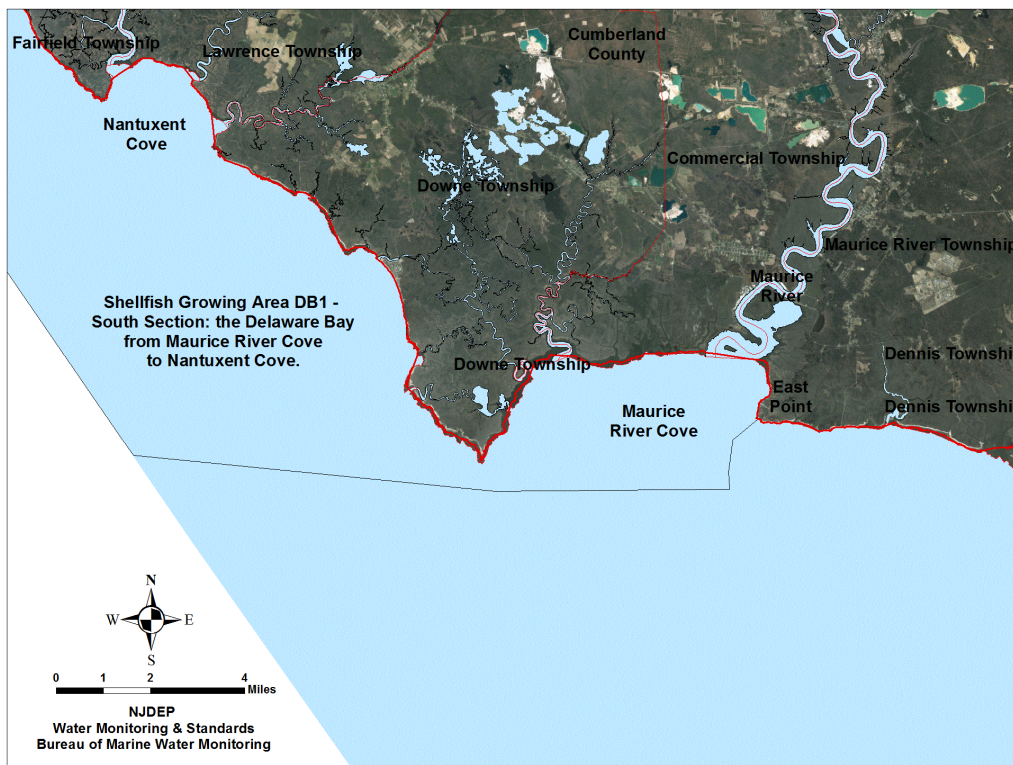
The *Conditionally Approved (November to April.)* waters are located in the Delaware Bay southeast of Bay Side, in the Delaware Bay west of Dunks Point, in the Delaware Bay west of Sea Breeze, in the Nantuxent Cove, in Back Creek, in lower Cedar Creek, in Beadons Cove, in Fishing Creek, in the Oranoaken Creek area, in the lower Dividing Creek area, in the Maurice River Cove outside Oranoaken Creek, in the Dividing Creek area, and in the Maurice River Cove outside the Maurice River. The *Restricted* waters are located in the Delaware Bay from Artificial Island to Cherry Tree Creek, in the Fishing Creek area, in the Mad Horse Creek area, in the Stow Creek area, in the Cohansey Cove, the north part of Cedar Creek, the upper Nantuxent Creek area, Dyer Cove, Dyer Creek, Padgett Creek, Sow and Pigs Creek, Beadons Creek, Fortescue Creek, the Straight Creek area, The Glades area, the upper Dividing Creek area, the lower Maurice River, and part of the Maurice River Cove. The *Prohibited* waters are located in the Hope Creek area, the Cohansey River area, the Middle Marsh Creek area, and the Maurice River area. The *Suspended* waters are located in the Delaware Bay, in the Nantuxent Cove, and in the Nantuxent Creek off the shore of Gandy's Beach and Money Island. The *Approved* waters are located in the Delaware Bay southeast of Cherry Tree Creek to the Maurice River Cove, excluding the areas already mentioned above.

In Cumberland County, the Maurice River, Dividing Creek, Oranoaken Creek, Straight Creek, Fishing Creek, Fortescue Creek, Beadons Creek, Sow and Pigs Creek, Padgett Creek, Dyer Creek, Nantuxent Creek, Cedar Creek, Back Creek, Oyster Gut, Middle Marsh Creek, Drumbo Creek, the Cohansey River, Cabin Creek, Fishing Creek, and Jacobs Creek drain into this shellfish growing area. In Salem County, Stow Creek, Muddy Creek, Cherry Tree Creek, Lower Deep Creek, Mad Horse Creek, Fishing Creek, Hope Creek, and the Delaware River drain into this shellfish growing area.

Location and Municipalities - North Section



Location and Municipalities - South Section



Growing Area Classification

The waters of this shellfish growing area are primarily classified as *Approved*, *Conditionally Approved (November-April)*, *Restricted*, *Prohibited*, and *Suspended* (see pages 2 and 3 for description of shellfish classification of this area).

In the 2013 Annual Review of Shellfish Growing Area DB1 for the Delaware Bay from Maurice River Cove to Artificial Island, 55 sampling stations exceeded the APC *Approved* fecal coliform year-round criteria, and two of these sampling stations (Sampling Stations 4103F and 3900D) were out of compliance with the existing shellfish growing water classification criteria. Sampling station 4103F, located in the Delaware Bay west of Dunks Point, exceeded the fecal coliform criteria year-round and in the summer for shellfish waters that were classified as *Approved* and Sampling Station 3900D, located in the Maurice River northeast of Bivalve, exceeded the fecal coliform criteria year-round, in the summer, and in the winter for shellfish waters that were classified as *Special Restricted*. It was proposed that the shellfish waters around these sampling stations would be closely monitored during shoreline surveys of this shellfish growing area.

In the Reappraisal of Shellfish Growing Area DB1 for the Delaware Bay, written in November 2013 using water quality data from 2005 to 2013, approximately 1,020.9 acres of the lower Maurice River near Sampling Station 3900D were downgraded from the *Restricted* to the *Prohibited* shellfish classification and approximately 94.4 acres of the Delaware Bay west of Dunks Point near Sampling Station 4103F were downgraded from the *Approved* to the *Conditionally Approved (November to April)* shellfish classification (NJDEP, 2014).

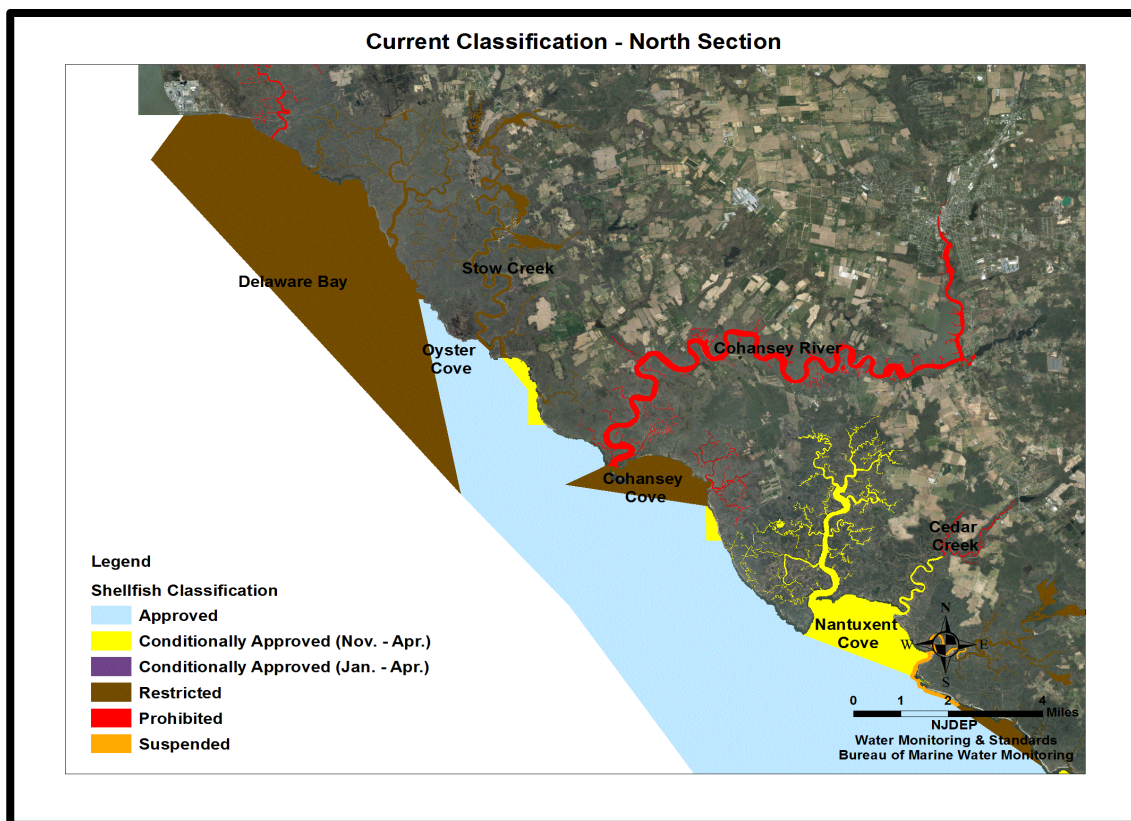
In the 2015 Annual Review of Shellfish Growing Area DB1 for the Delaware, all of the sampling stations in this growing area met their existing *Approved*, *Conditionally Approved (November to April)*, *Restricted*, and *Prohibited* shellfish classification criteria. Sampling Station 3869C in Straight Creek was also deactivated because Straight Creek had silted up and the boat captain could not get a boat to the station to collect the water samples.

In the 2016 Annual Review of Shellfish Growing Area DB1 (presented on October 2016), 46 sampling stations exceeded the APC fecal coliform year-round criteria, and one sampling station was out of compliance with the existing shellfish growing water classification criteria. Sampling station 4112E, located in the Delaware Bay northwest of Arnold Point, exceeded the fecal coliform criteria year-round and in the summer for shellfish waters that were classified as *Approved*. In the Annual Review, it was proposed that approximately 575.3 acres of *Approved* shellfish waters around this sampling station would be downgraded to the *Restricted* shellfish classification to make it consistent with the nearby *Restricted* shellfish waters northwest of this sampling station. In the discussion during the Annual Review, it was agreed to downgrade this area to the *Conditionally Approved (November to April)* shellfish classification because the sampling station met the *Conditionally Approved (November to April)* shellfish classification criteria. In mid-February after the initially agreed-upon downgrade was written up, submitted, and approved, an administrative decision was submitted to rewrite the downgrade to include only the waters in the Delaware Bay along the coast of the Stow Creek area and the area of the downgrade was reduced to approximately

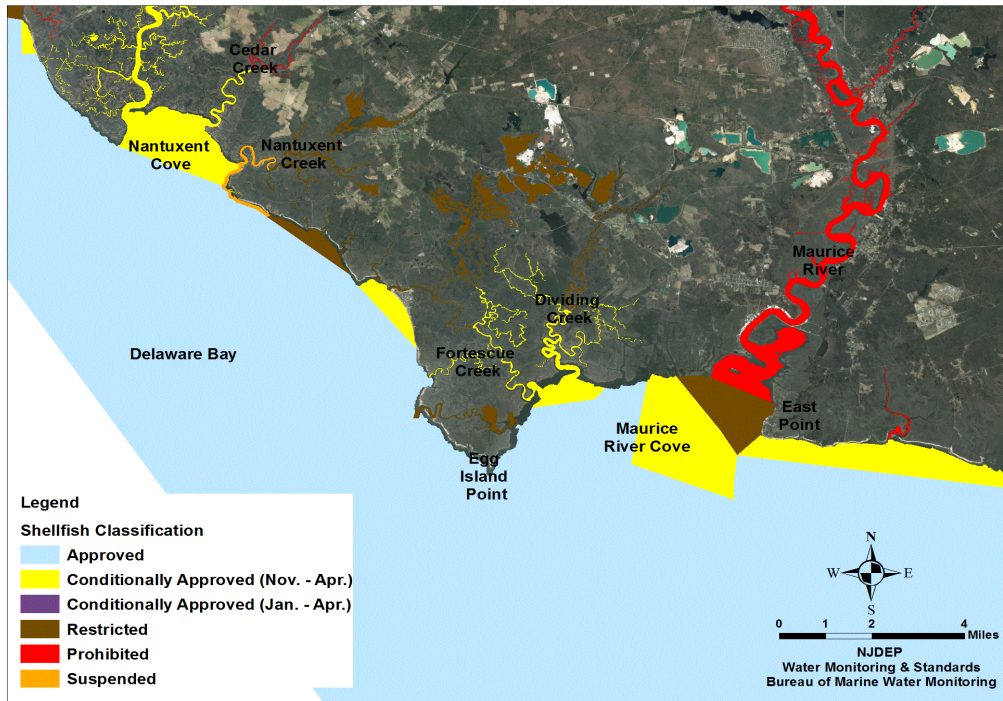
392.4 acres. Also, in the 2016 Annual Review of Shellfish Growing Area DB1, Sampling Station 3847J, located in the Maurice River Cove in *Restricted* shellfish waters, had data results that showed that only nine samples/runs had been collected since it was created on 3/17/2015 at the request of the Delaware Bay Section of the New Jersey Shellfisheries Council. Since a minimum of 15 samples/runs are needed for an analysis, at least six more samples/runs need to be collected at this station. Sampling Station 3847J in Assignment 332 is sampled six times a year. Therefore, another year of water quality data is needed to do an analysis of the water quality at this sampling station.

The last Sanitary Survey for Shellfish Growing Area DB-1 (the Delaware Bay from Maurice River Cove to Artificial Island) was written in March 2004 using water quality data from 1999 to 2003. In this report, approximately 224 acres of *Conditionally Approved (November to April)* shellfish waters in the Maurice River Cove were downgraded to the *Restricted* shellfish classification due to degradation of the water quality in the Maurice River Cove (Wesighan, 2005).

The figures below and on the next page illustrate the shellfish classification for this growing area. The shellfish classification of this area can be seen in the 2016 State of New Jersey Shellfish Growing Water Classification Charts booklet on chart number 18 and 19, or on WM&S/BMWM's website at <http://www.state.nj.us/dep/bmw/>.



Current Classification - South Section



Evaluation of Biological Resources

This growing area has a wide variety of biological resources. The eastern oyster (*Crassostrea virginica*) exists in medium abundance in the Delaware Bay, and has a long history of its commercial and economic importance in the Delaware Estuary (Morris, 1975, Gosner, 1978, Matassino, et al, 2002). The table on this page shows the New Jersey eastern oyster direct market harvest landings totals for the Delaware Bay from 2011 to 2016 (NJDEP, Division of Fish and Wildlife, Bureau of Shellfisheries, 2017). The first table on page 9 shows the New Jersey eastern oyster direct market harvest landings totals for the Delaware Bay by area for 2016 (NJDEP, Division of Fish and Wildlife, Bureau of Shellfisheries, 2017).

The second table on page 9 shows the total New Jersey shellfish landings data from 2011 to 2016 (NMFS, 2017). Shellfish landing statistics had not been verified and posted for 2016 at the time this sanitary survey report was written. These shellfish species include blue crabs (*Callinectes sapidus*), blue crabs – peelers, hard clams (*Mercenaria mercenaria*), blue mussels (*Mytilus edulis*), bay scallops (*Aequipecten irradians*), oysters (*Crassostrea virginica*), ocean quahogs (*Arctica islandica*), surf clams (*Spisula solidissima*), and sea scallops (*Placopecten magellanicus*) (Morris, 1975, Gosner, 1978). However, this report primarily focuses on bivalve mollusks, such as clams, quahogs, oysters, and mussels, and does not include crustaceans, such as blue crabs.

New Jersey Eastern Oyster Direct Market Harvest Landing Totals for the Delaware Bay - 2011 to 2016 (NJDEP, NJ Division of Fish and Wildlife, Bureau of Shellfisheries, 2017).

NEW JERSEY EASTERN OYSTER DIRECT MARKET HARVEST LANDING TOTALS for the DELAWARE BAY 2011 to 2016		
YEAR	BUSHELS	\$ VALUE
2011	94,470	\$3,306,450
2012	78,140	\$2,344,200
2013	84,276	\$3,371,040
2014	76,910	\$3,076,400
2015	87,430	\$3,934,350
2016	100,095	\$4,504,275

**New Jersey Eastern Oyster Direct Market Harvest Landings Totals in the Delaware Bay by Area
for 2016 (NJDEP, NJ Division of Fish and Wildlife, Bureau of Shellfisheries, 2017)**

NEW JERSEY EASTERN OYSTER DIRECT MARKET HARVEST LANDING TOTALS in the DELAWARE BAY by AREA for 2016		
NAME OF AREA	BUSHELLS	\$ VALUE
BENNIES	29,293	\$1,318,185
COHANSEY	12,475	\$561,375
NANTUXENT	2,101	\$94,545
NEW BEDS	4,494	\$202,230
SHELL ROCK	31,794	\$1,430,730
SHIP JOHN	19,938	\$897,210
TOTAL	100,095	\$4,504,275

New Jersey Shellfish Landings - 2011 to 2016 (NMFS, 2017).

NEW JERSEY SHELLFISH LANDINGS 2011 to 2015		
YEAR	POUNDS OF MEAT (millions)	\$ VALUE (exvessel)
2011	65,434,503	\$177,412,023
2012	57,693,336	\$146,022,490
2013	45,992,234	\$96,264,744
2014	55,569,046	\$120,369,860
2015	53,147,052	\$143,441,691
2016	*	*

*No Data

The cities of Port Norris and Bivalve, along the Maurice River in Cumberland County, were once known as the hub of the Delaware Bay oyster industry, and Bivalve was once recognized to be the oyster capital of the world for its oyster production and processing industries. Their oyster industry processed and delivered thousands of pounds of oysters to markets all over the eastern coast of the United States (Flemlin and Tweed, 2000, Matassino, et al, 2002).

The population of oysters in the Delaware Bay had fluctuated widely. In the early 1900's, annual oyster landings were from one million to two million bushels. However, in the 1950's, the oyster population was reduced dramatically by the disease MSX, which is caused by the parasite *Haplosporidium nelsoni*. Only 49,000 bushels of oysters were harvested in the Delaware Bay in 1960. There was a gradual increase in the numbers of oysters harvested in the late 1960's and early 1970's. Then, in 1990, a new disease named Dermo was found to be spreading among the oyster population on the eastern side of the Delaware Bay and it caused heavy losses of both planted and seeded oysters. Dermo is caused by the parasite *Perkinsus marinus*. In 1988, juvenile oyster disease (JOD) also became a serious problem for oyster nurseries in the northeastern Atlantic region. The causative agent for JOD is unknown (Guo, Dr. Ximing, and Dr. John Kraeuter, 2000). While MSX, Dermo and JOD are diseases of oysters, they do not infect humans and therefore do not have any public health significance.

The Haskin Shellfish Research Laboratory of Rutgers University has attempted to develop disease resistant strains of oysters that show a resistance to MSX. Their long-term oyster-breeding program has genetically produced a disease resistant strain of oysters for MSX, and they have also genetically produced an oyster with some resistance to Dermo. These disease-resistant oysters are the main production line for the Atlantic Cape Fisheries oyster farm in Cape May (Guo and Kraeuter, 2000).

The Delaware Bay also contains the world's largest population of horseshoe crabs (*Linulus polyphemus*). In New Jersey for 2005, the landings for horseshoe crabs were 330,714 pounds harvested for an exvessel value of \$120,782 (NMFS, 2016). After 2005, there was a moratorium placed on the harvest of horseshoe crabs in the Delaware Bay, and horseshoe crab landings for 2006 were 9,141 pounds harvested for an exvessel value of \$3,474 (NMFS, 2016). A total moratorium was placed on the harvest of horseshoe crabs in New Jersey for 2007 and, from 2007 to 2016; the National Marine Fisheries Service has no values for horseshoe crab landings in New Jersey for those year. Since horseshoe crabs are used as bait for catching eels and conch, and their natural habitat is gradually being lost to development and shoreline retreat, the population of horseshoe crabs has been declining. Migrating shorebirds also feed on the eggs of nesting horseshoe crabs, which also contributes to their decline in population numbers (Matassino, et al., 2002).

For migrating shorebirds, the Delaware Bay is located along the Atlantic Flyway, which is an important migratory corridor for wildlife populations of shorebirds along the eastern half of the United States. The Delaware Bay area is considered to be one of the largest stopover locations along the Atlantic Flyway, with an estimated 425,000 to 1,000,000 migratory shorebirds converging and feeding in the Delaware Bay Estuary. Red Knot, Dunlin, Ruddy Turnstone, Sanderling, Semi-Palmated Sandpiper, and other species of shorebirds use the Delaware Bay Estuary as an important resting and feeding area, and they

are known to consume large quantities of horseshoe crab eggs (certain species of shorebirds can and will eat thousands of horseshoe crab eggs in a single day) (Matassino, et al., 2002).

Blue crabs (*Callinectes sapidus*) are also found in the waters of the Delaware Bay and they are commercially and recreationally harvested from these waters. In New Jersey for 2011, the landings of blue crabs were 9,599,249 pounds harvested for an exvessel value of \$9,418,029 (NMFS, 2017). In New Jersey for 2015, the landings of blue crabs were 7,242,785 pounds harvested for an exvessel value of \$8,666,745 (NMFS, 2017). The National Marine Fisheries Service has no values for blue crab landings in New Jersey for 2016 on the date this report was written. Striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*) are also an important biological resource in the Delaware Bay and Delaware River (Matassino, et al., 2002). Both of these species of fish are commercially and recreationally harvested in the waters of this shellfish growing area, since this area is also utilized for fishing and boating. In 1991, the striped bass was classified as a gamefish in New Jersey, and this status prevents the commercial harvest or sale of this first coastal saltwater species designated as such in New Jersey (Bochenek, 2000).

The wetlands bordering this shellfish growing area also contain the Corsons Wildlife Management Area, the Heislerville Wildlife Management Area, the Turkey Point Fish & Wildlife Management Area, the Egg Island Berrytown Wildlife Management Area, the Fortescue Wildlife Management Area, the Nantuxent Wildlife Management Area, the New Sweden Wildlife Management Area, the Dix Fish & Wildlife Management Area, the Osborn Fish & Wildlife Management Area, and the Mad Horse Creek Wildlife Management Area.

SHORELINE SURVEY: EVALUATION OF POTENTIAL POLLUTION SOURCES

Shoreline Survey

The shoreline survey for Shellfish Growing Area DB-1: the Delaware Bay from Maurice River Cove to Artificial Island was started on November 22, 2016. On that date, an inspection was conducted of the City of Millville Wastewater Treatment Facility and recent modifications to the infrastructure were observed. Wayne Johnson, the facility chief engineer gave me the GPS coordinates for the facility, all of the pump stations (21), and all of the stormwater outfall pipes (25) discharging into the Maurice River for the City of Millville.

On February 10, 2017, an inspection was conducted of the Cumberland County Utilities Authority (Bridgeton) Wastewater Treatment Facility. Dan Jefferson, the facility Director, and Mike Fernandez, the facility engineer gave me a tour of the plant, and Dan Jefferson provided me with the GPS coordinates for the pump stations (6) from the surrounding areas that were pumping to the Cumberland County Utilities Authority (Bridgeton) Wastewater Treatment Facility. Jerome Cassidy of the City of

Bridgeton Public Works provided me with the GPS coordinates for the stormwater outfall pipes (102) discharging into the Cohansey River for the City of Bridgeton.

On April 6, 2017, an inspection was conducted of the Canton Village and Hancock's Bridge Sewerage Treatment Plants (STP). Both of these small "package" STP's (design flow of 0.05 million gallons/day) are owned, permitted, and maintained by Lower Alloways Creek Township in Hancock's Bridge, NJ. The Canton Village STP provides service to the area of Canton, NJ, and the Hancock's Bridge STP provides service to Harmersville and Hancock's Bridge, NJ. There are four (4) pump stations that handle the flow of the force mains that conveys the raw sewage to the Hancock's Bridge STP and four (4) pump stations that handle the flow of the force mains that conveys the raw sewage to the Canton Village STP. Water samples were collected at the Hancock's Bridge and Canton Village STP's from the outfall pipe after the chlorine contact chamber from an access manhole along the outfall pipe. Matthew Goff, the principal planning aide for the County of Salem Department of Planning & Agriculture provided me with the GPS coordinates and physical locations of the pump stations from the surrounding areas that were pumping to the Canton Village and Hancock's Bridge Sewerage Treatment Plants in Lower Alloway's Creek Township.

On May 23, 2017, a shoreline survey was conducted in the Upper Delaware Bay for the coastal Stow Creek area, which is the area proposed for a downgrade of the water quality from *Approved* to *Restricted* for 392.4 acres of the Delaware Bay included in this report. Photos of this area were taken and the shoreline was observed to determine the source of the elevated fecal coliform levels at sampling station **4112E**.

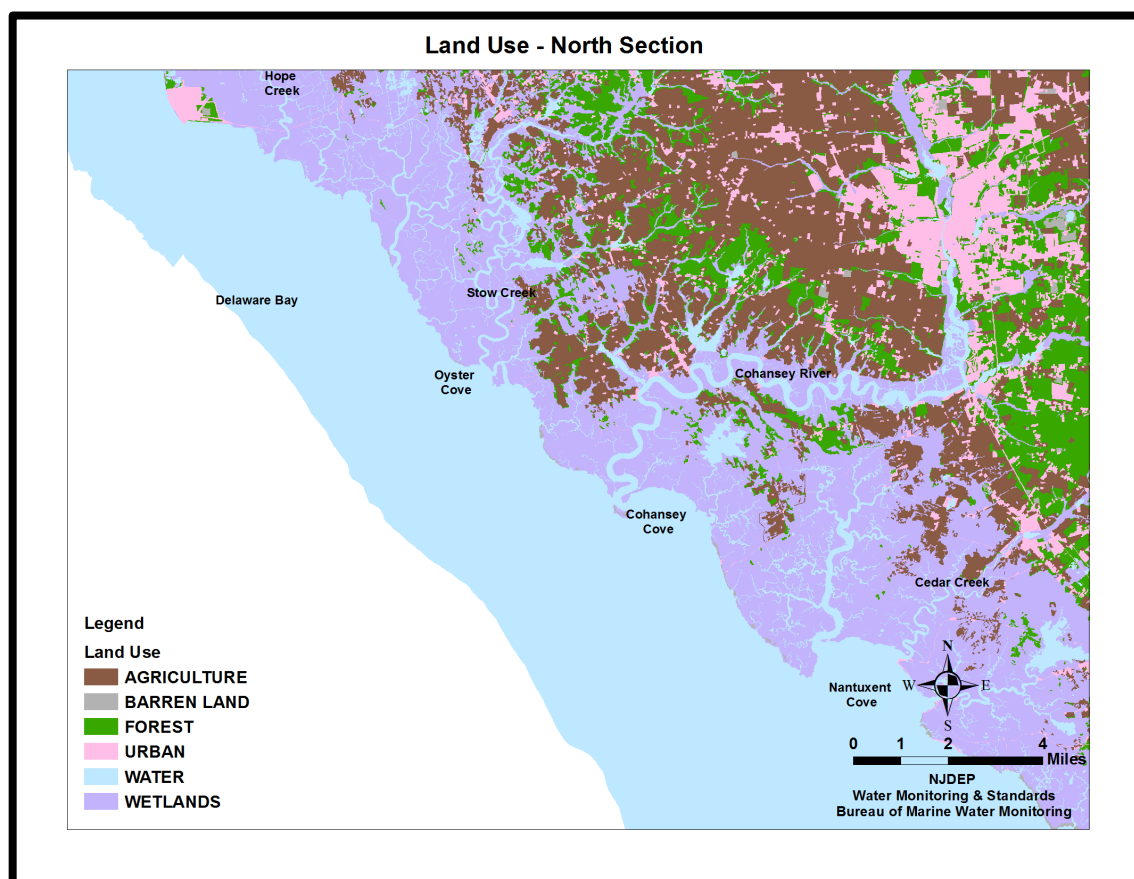
During the shoreline surveys conducted in and around the Delaware Bay, no evidence could be seen that direct and indirect discharges from potential sources of pollution draining into Shellfish Growing Area DB1 were having an impact on the water quality of this area, with the exception of the Upper Delaware Bay –Coastal Stow Creek area which is being downgraded in this report.

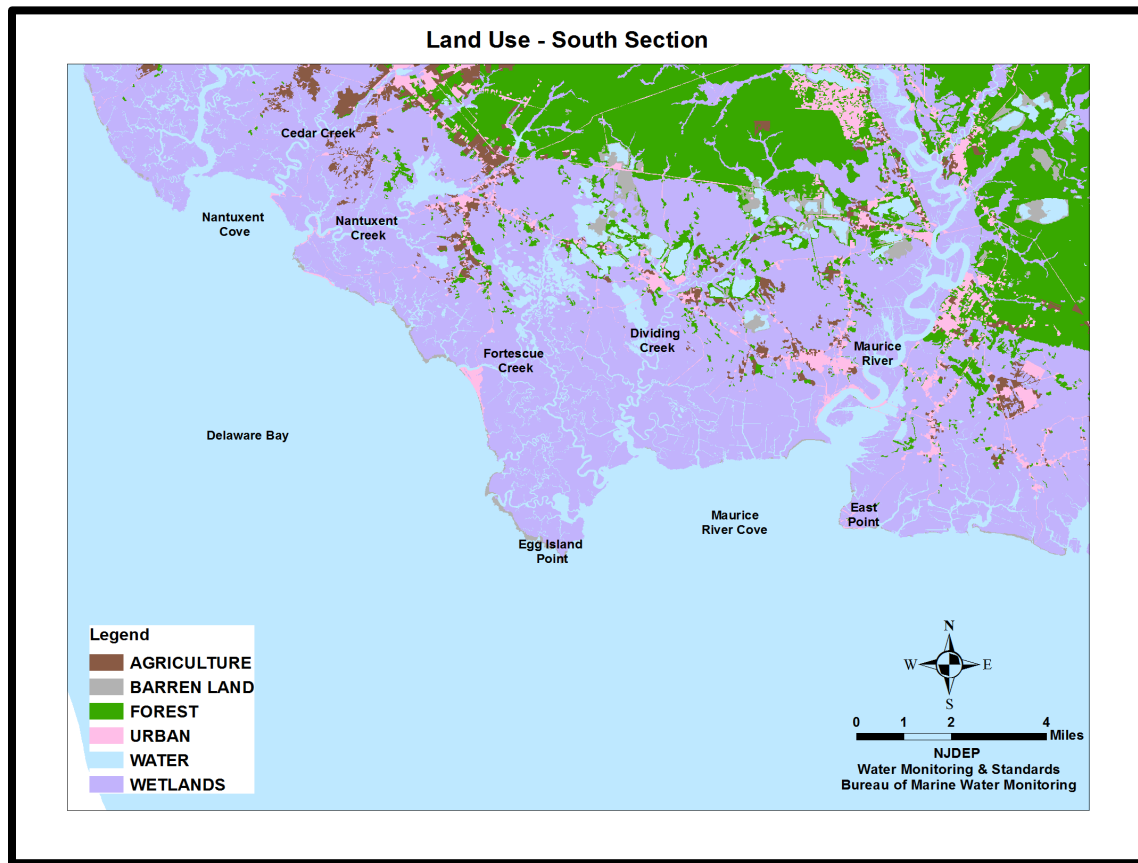
There have been some changes to this area since the 2004 partial sanitary survey of this shellfish growing area. The major changes to this area are primarily concerned with the continuous shoreline erosion over time and the impact of this to the shoreline communities around the Delaware Bay. During the shoreline survey of the upper Delaware Bay on June 30, 2016, a lot of the homes in Bayside had been completely removed, with only eight (8) houses remaining and two (2) of these eight houses were completely boarded up. The cover photo of the City of Millville Wastewater Treatment Facility discharge pipe extending into the Maurice River in Millville was taken during the inspection of the facility on November 22, 2016.

Land Use

The major land use patterns for the municipalities adjacent to this shellfish growing area are mainly wetland areas, agricultural areas, and forest areas, with some urban and rural areas interspersed between them. The urban areas are mainly located to the north and northeast of this shellfish growing area and the cities of Bridgeton and Millville are connected to public sewer systems where there is a minimal potential for pollutant inputs into these shellfish growing waters from sewage contamination (APHA, 1995). Based on a review of water quality data, there is no current evidence that the direct and indirect discharges from these surrounding urban areas affects the water quality of this shellfish growing area.

The wetlands bordering this shellfish growing area also contain the Corsons Wildlife Management Area, the Heislerville Wildlife Management Area, the Turkey Point Fish & Wildlife Management Area, the Egg Island Berrytown Wildlife Management Area, the Fortescue Wildlife Management Area, the Nantuxent Wildlife Management Area, the New Sweden Wildlife Management Area, the Dix Fish & Wildlife Management Area, the Osborn Fish & Wildlife Management Area, and the Mad Horse Creek Wildlife Management Area. The figures on the next page show the land use that surround this shellfish growing area.



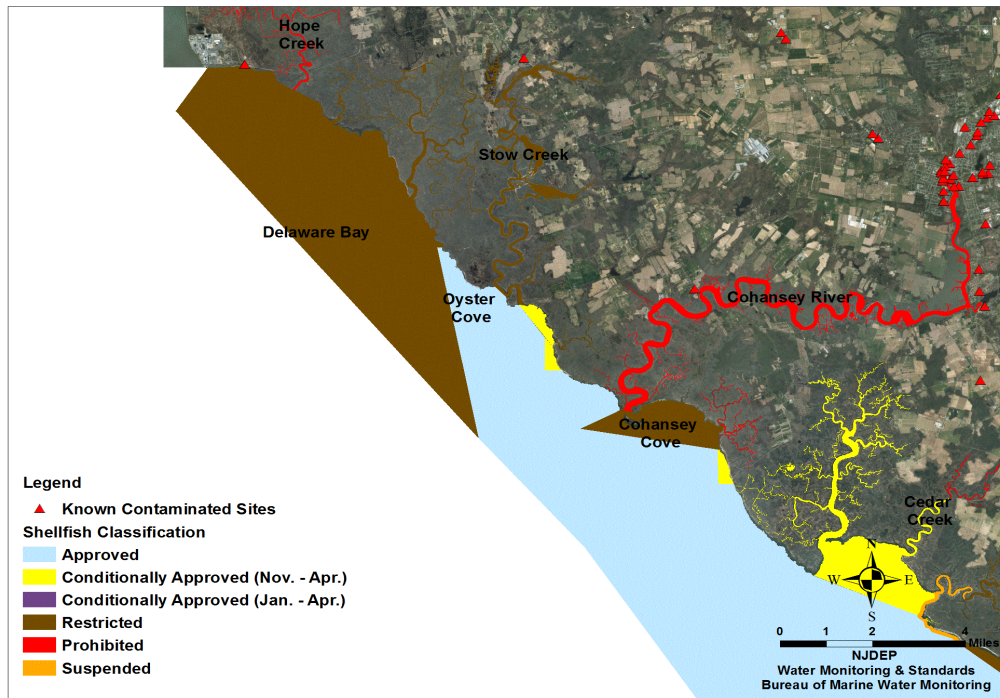


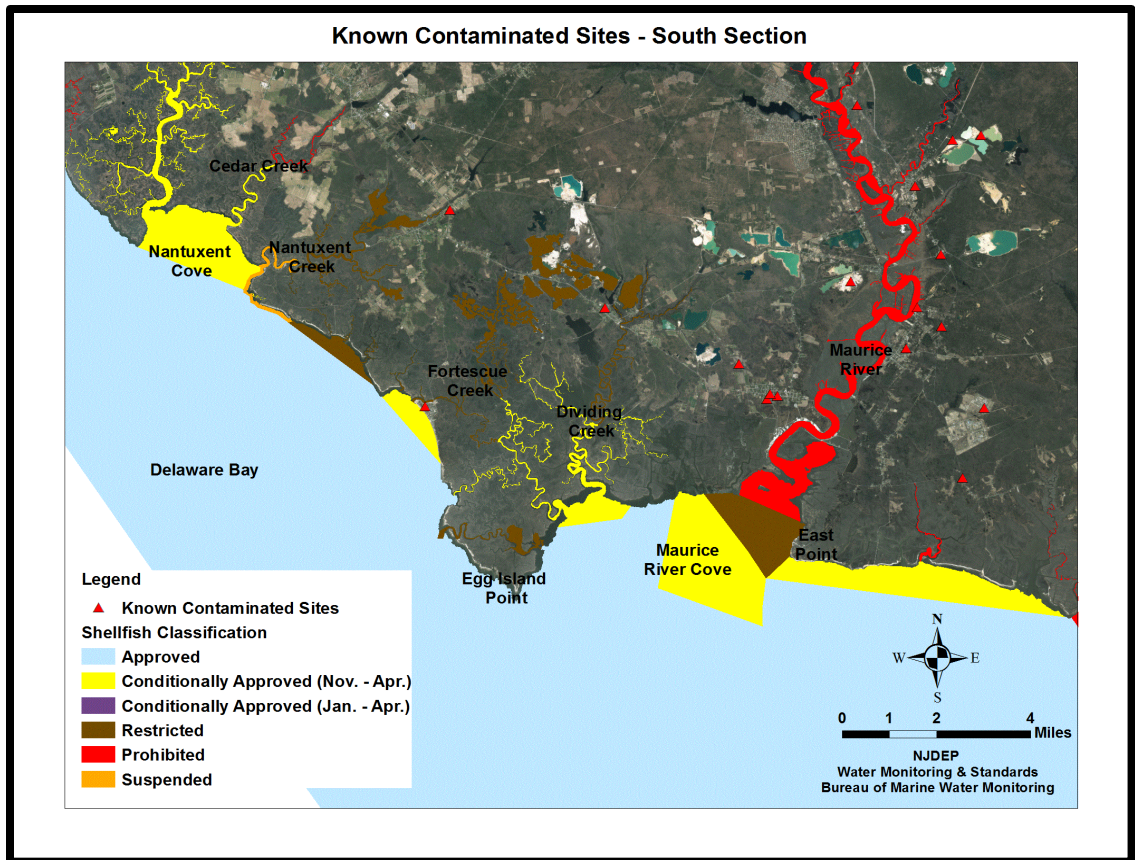
Known Contaminated Sites

NJDEP, Site Remediation Program (SRP) has established a list of the Known Contaminated Sites (KCSNJ), Classification Exception Area (CEA) and Currently Known Extent (CKE) of groundwater pollution. KCSNJ are those non-residential sites and properties within the state where contamination of soil or groundwater has been confirmed at levels equal to or greater than applicable standards. This list of Known Contaminated Sites may include sites where remediation is either currently under way, required but not yet initiated or has been completed. CEA and CKE areas are geographically defined areas within which the local groundwater resources are known to be compromised because the water quality exceeds drinking water and groundwater quality standards for specific contaminants (NJDEP).

This shellfish growing area, which extends from the Maurice River Cove to Artificial Island, has several known contaminated sites located in the adjacent areas (see figures below and on next page). The major concentrations of these known contaminated sites are located along the east and west shorelines of the Maurice River near Leesburg, Dorchester, and Port Norris, and along the east and west shorelines of the Cohansey River in Bridgeton. The primary causes of these known contaminated sites are from leaking underground storage tanks. Most of these known contaminated sites are now closed.

Known Contaminated Sites - North Section





Direct Discharges

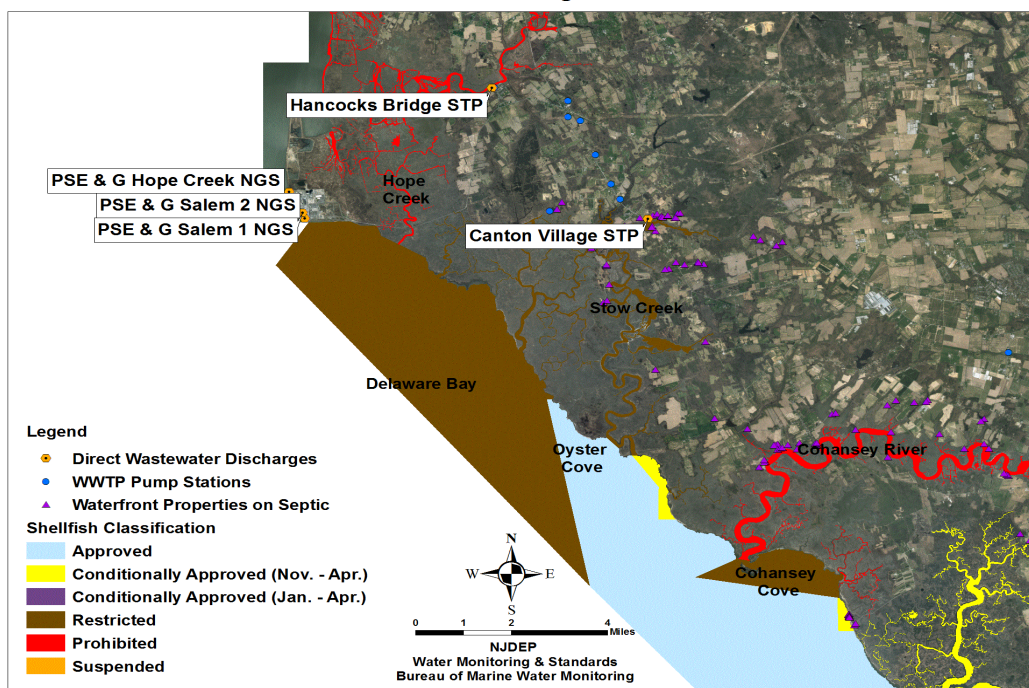
There are seven permitted municipal point source discharges in Area DB1 (The Delaware Bay from Maurice River Cove to Artificial Island). Three of these municipal point sources discharge industrial wastewater from their cooling systems directly into the waters of the Delaware Bay off of Artificial Island and they are: the PSE & G Hope Creek Nuclear Generating Station wastewater discharge pipe, the PSE & G Salem 1 Nuclear Generating Station wastewater discharge pipe, and the PSE & G Salem 2 Nuclear Generating Station wastewater discharge pipe. The Hancock's Bridge Sewage Treatment Plant discharges domestic wastewater directly into Alloways Creek, the Canton Village Sewage Treatment Plant discharges domestic wastewater directly into Stow Creek, the Cumberland County Utilities Authority (Bridgeton) WWTP discharges domestic wastewater directly into the Cohansey River, and the City of Millville Sewage Authority WWTP discharges domestic wastewater directly into the Maurice River. All of these rivers, creeks, and tributaries flow into the Delaware Bay and are part of this shellfish growing area. The figures on page 18 show the locations of these municipal point sources and their pump stations.

Since there is a potential for pollutant inputs from these indirect sources to get into these shellfish growing waters, it is important to continue monitoring the water quality of these areas to determine the presence or absence of these indirect sources of pollution (APHA, 1995)

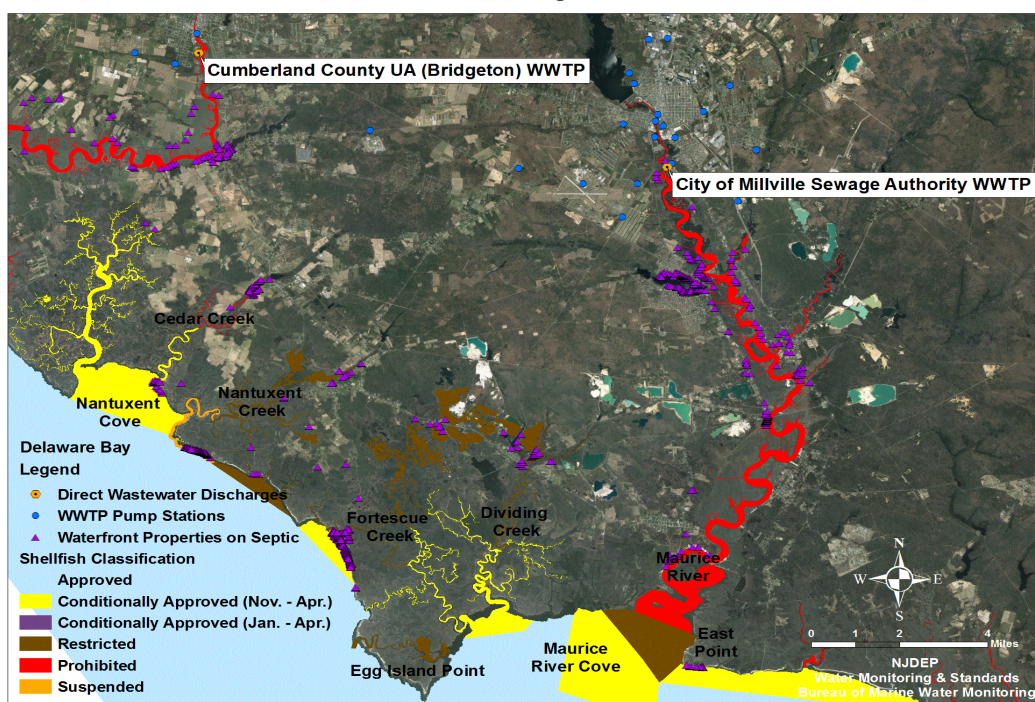
Direct Wastewater Discharges to Shellfish Growing Area DB1: The Delaware Bay from Maurice River Cove to Artificial Island.

Map Key	Discharge	Waste Type	Waste Quantity	Pump Stations
1	PSE & G Hope Creek Nuclear Generating Station (NGS)	Industrial Wastewater from Cooling System	48.2 MGD	N/A
2	PSE & G Salem 1 Nuclear Generating Station (NGS)	Industrial Wastewater from Cooling System	30.24 MGD	N/A
3	PSE & G Salem 2 Nuclear Generating Station (NGS)			
4	Hancock's Bridge STP	Domestic Wastewater	0.05 MGD	4
5	Canton Village STP	Domestic Wastewater	0.05 MGD	4
6	Cumberland County Utilities Authority (Bridgeton) WWTP	Domestic Wastewater	7.0 MGD	6
7	City of Millville Sewage Authority WWTP	Domestic Wastewater	5.0 MGD	21

Direct Wastewater Discharges - North Section

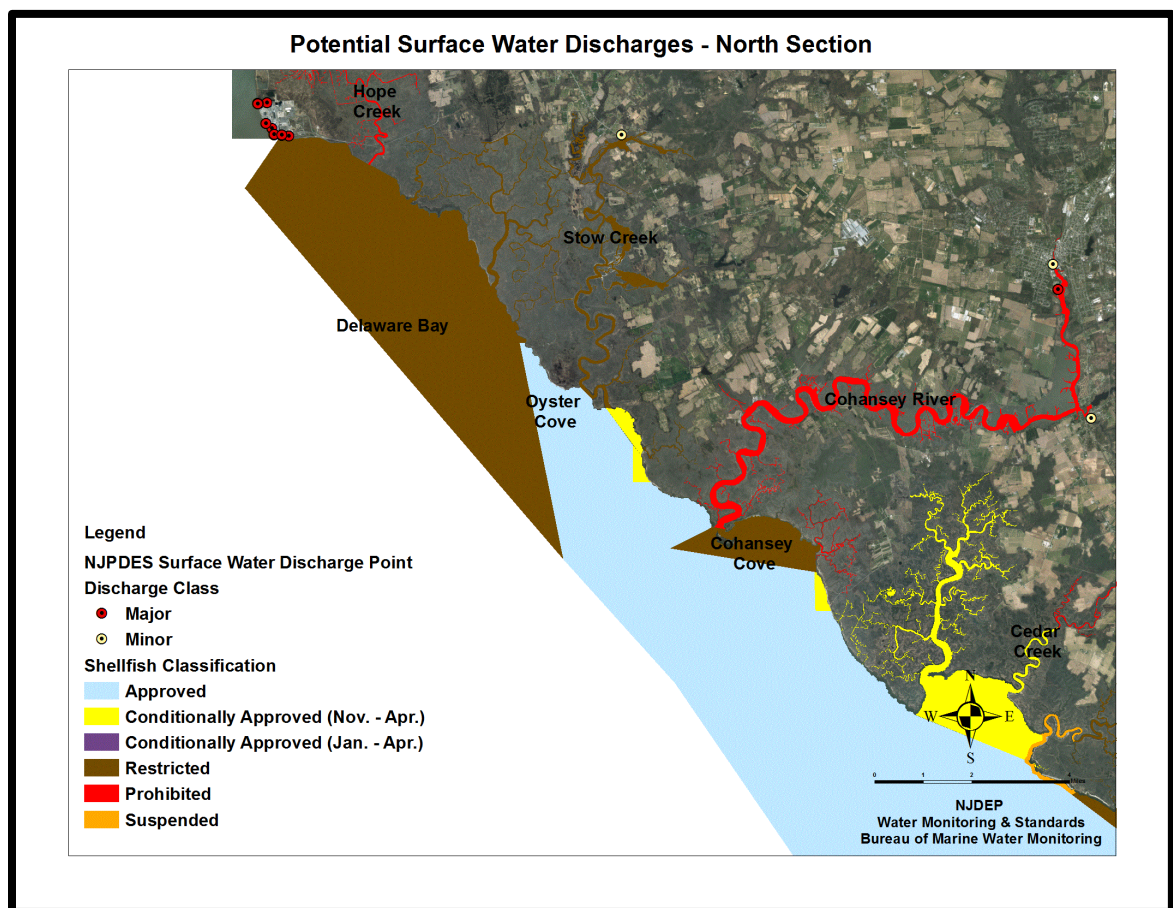


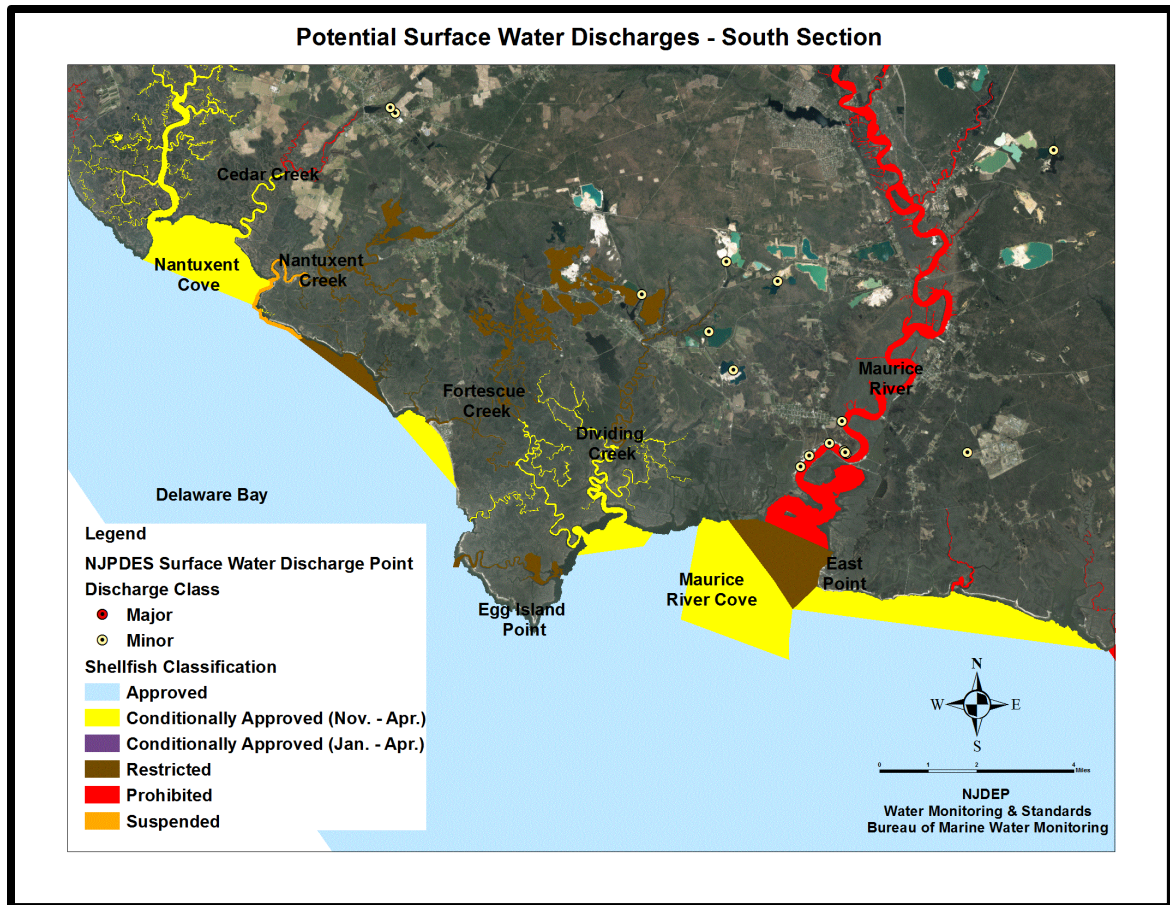
Direct Wastewater Discharges - South Section



Surface Water Discharges

The discharge of pollutant from a point source is authorized under New Jersey Pollutant Elimination System (NJPDES), and the regulations are found at N.J.A.C. 7:14A. The main purpose of the NJPDES program is to ensure proper treatment and discharges of wastewater. By doing so, the permit limits the amount or concentration of pollutants that can be discharged into ground water, streams, rivers, and the ocean. Facilities regulated under this program include mines, schools, hospitals, large corporate office buildings, industrial manufacturing facilities, campgrounds, mobile home parks, food processor, potable water treatment plants, sewage treatment plants, or any dischargers that may have the potential to impact water quality. As of November 2015, there were 2,290 active permits for major and minor surface water discharge points in New Jersey. The number of active permits includes permits for all NJPDES permit classes, including Discharge to Surface Water (DSW), Discharge to Groundwater (DGW), Significant Indirect User (SIU), Discharge of Stormwater (DST), and Residuals (RES), (NJDEP, Division of Water Quality).



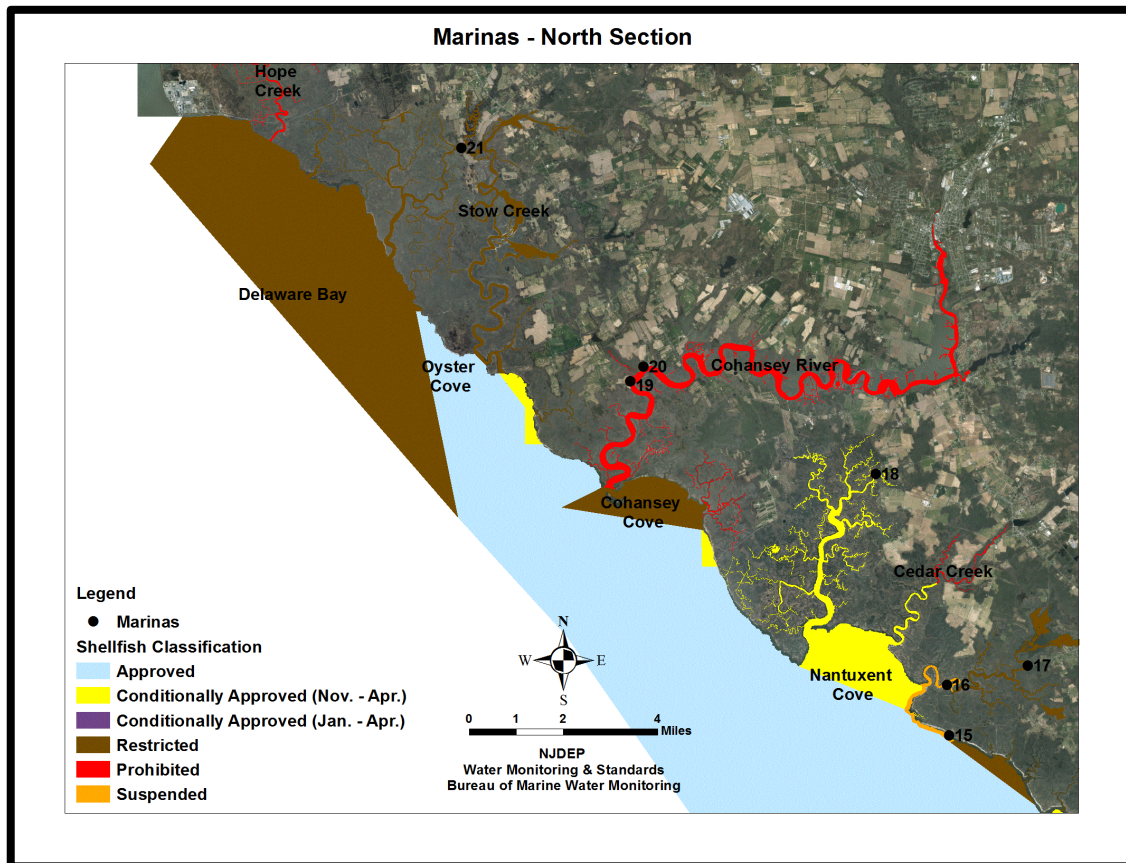


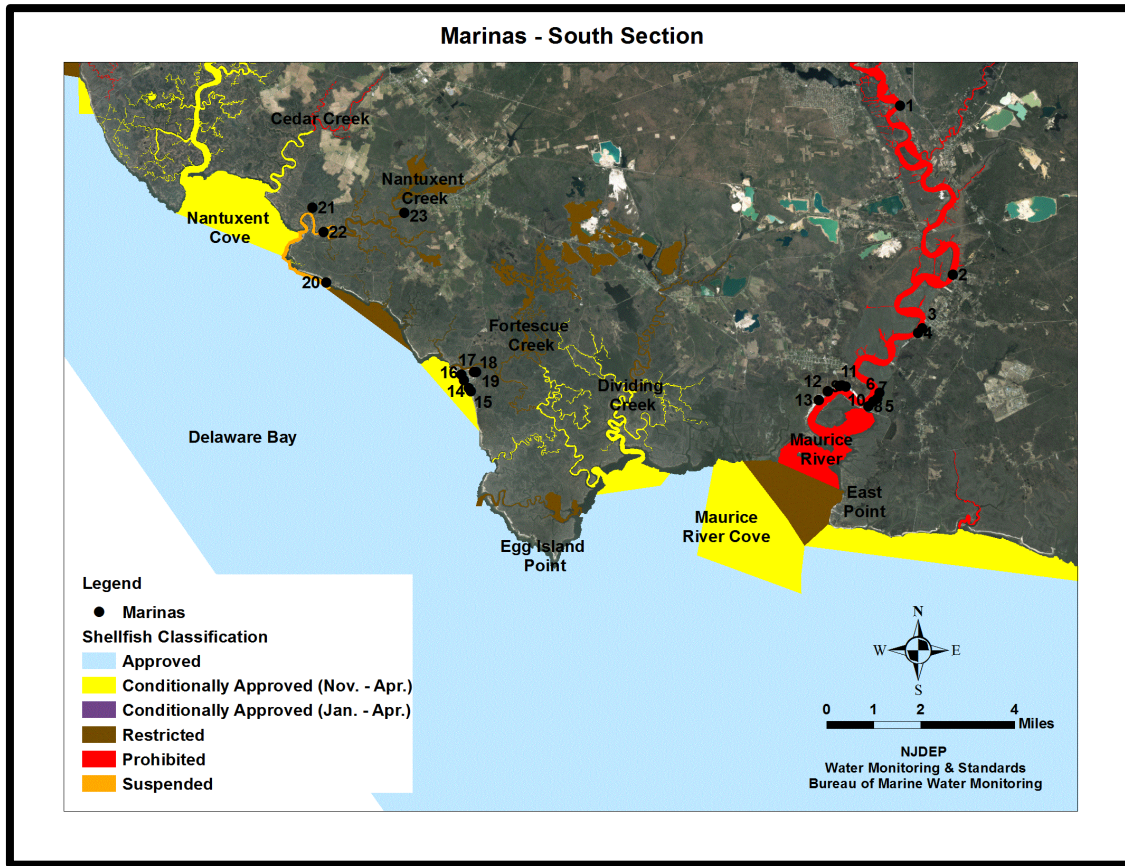
Marinas

The discharge of sewage from vessels into the waterways can contribute to the degradation of the marine environment by introducing disease-causing microorganisms (pathogens), such as bacteria, protozoan, and viruses, into the marine environment. Chemical compounds, such as oil and gasoline resulting from spills, leaks, and pressure washing from vessels can poison fish and other marine organisms. Research has shown that by-products from the biological breakdown of petroleum products can harm fish and wildlife, and pose threats to human health if ingested. (NOAA) For this reason, waters within the marina basin are restricted to shellfish harvesting. Depending on the size of the marina, the water quality, flushing rates, and the depth of the water, shellfish waters immediately adjacent to each marina may be classified as *Prohibited*, *Restricted*, or *Conditionally Approved* (no harvest during summer months when the marina is normally active). There are twenty one (21) marinas situated within this shellfish growing area.

To protect waters from the pollution generated by marina related activities, NJDEP implemented the New Jersey Clean Marina Program. This is a volunteer based program for marinas. The program provides assistance and guidance to marinas as well as boaters on ways to reduce pollution, including sewage facility management, fueling operations, fish and solid waste management and boat cleaning. Currently, there are only a small percentage of marinas in the

state that do participate in this program. The lists of marinas that are certified and/or pledged under this program are on <http://www.njcleanmarina.org/>.





Marina Facilities Located in Shellfish Growing Area DB1: The Delaware Bay from Maurice River Cove to Artificial Island.

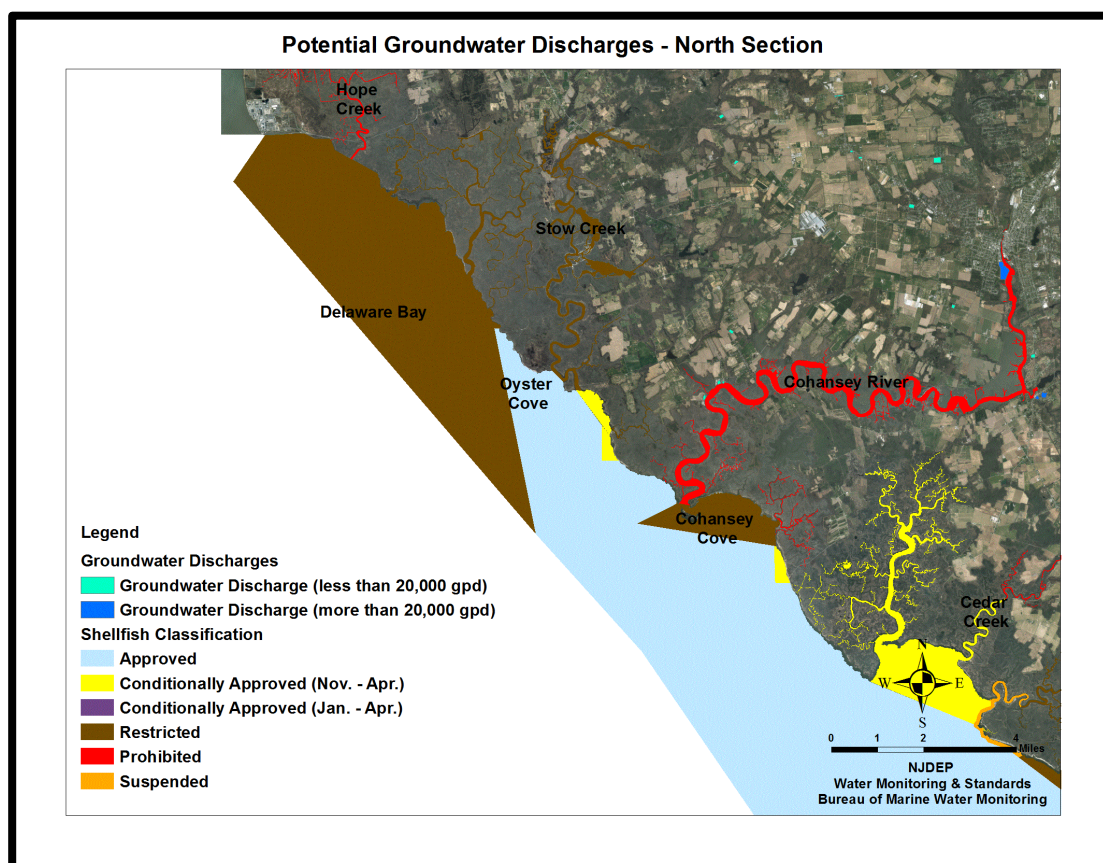
Map Key	Marina Name	Location	# of Wet Slips Total/Boats > 24ft.	Size of Buffer Area (radius; feet)	Average Water Depth (ft)	Pumpout Facility
1	Spring Garden Marina	Maurice River Township	45/23	1074	2	Yes
2	Cox's Penny Hill Marina	Maurice River Township	17/5	208	15	No
3	Boat World Marina	Maurice River Township	140/70	842	10	Yes
4	Four Star Marina	Maurice River Township	212/100	1,018	10	Yes
5	Anchor Marina	Maurice River Township	120/47	767	9	No

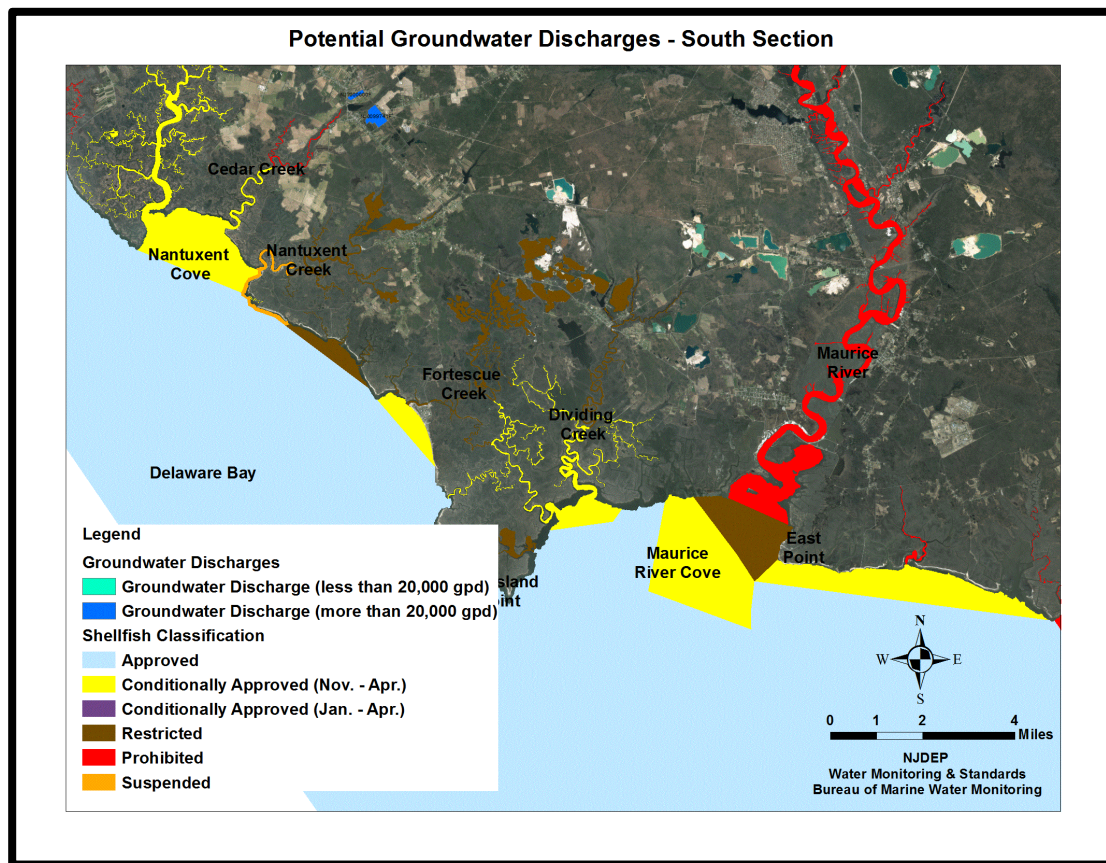
Map Key	Marina Name	Location	# of Wet Slips Total/Boats > 24ft.	Size of Buffer Area (radius; feet)	Average Water Depth (ft)	Pumpout Facility
6	Haase Marina	Maurice River Township	80/10	502	9	No
7	Poppeye's Marina	Maurice River Township	115/55	794	9	No
8	Robinson's Marina	Commercial Township	75/13	510	9	No
9	Port Norris Marina	Commercial Township	200/55	863	10	No
10	Sail Loft Marina	Commercial Township	19/3	253	9	No
11	Long Reach Marina	Commercial Township	98/24	833	5	Yes
12	Double A Marina	Downe Township	16/0	289	4	No
13	Fortescue State Marina	Downe Township	125/70	1,163	5	Yes
14	Higbee's Marina	Downe Township	20/0	289	5	No
15	Gandy's Beach Marina	Downe Township	60/0	501	5	No
16	Money Island Marina	Downe Township	60/0	289	15	No
17	Sundog Marina	Downe Township	60/60	830	7	No
18	Husteds Landing Marina	Fairfield Township	70/0	698	3	No
19	Hancocks Harbor Marina	Greenwich Township	125/63	728	12	No

Map Key	Marina Name	Location	# of Wet Slips Total/Boats > 24ft.	Size of Buffer Area (radius; feet)	Average Water Depth (ft)	Pumpout Facility
20	Greenwich Boat Works	Greenwich Township	250/125	649	30	Yes
21	Mad Horse Creek WMA	Lower Alloways Creek Township	15/15	415	7	No

Groundwater Discharges

According to NJPDES, there are several facilities with active Discharge to Groundwater (DGW) permits in this area. Besides groundwater discharger, septic systems are widely used in remote area where public sewer lines are inaccessible. When septic systems fail to function properly, it could lead to groundwater contamination. The location of groundwater injection, surface water discharge (stormwater), areas are shown in the figure below.





Spills, Unpermitted Discharges, and Closures

On April 19, 2011, a sewage spill was reported for the area of 355 Fowser Road at the Millville Sewage Authority Wastewater Treatment Facility near the Maurice River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 307,000 gallons of partially treated sewage was discharged into the Maurice River at this location because one of the clarifiers was down due to construction and the other clarifier couldn't handle the overflow from the discharge that comes from the Delmonica Foods plant. The flow of the sewage treatment facility was diverted to their south plant. When I spoke to Jim Grob of the Millville Sewage Authority Wastewater Treatment Facility on April 20, 2011 at 11:23 AM, I was told that both clarifiers would be up and running in two days but the current flow would continue to be diverted to their south plant. The shellfish classification of the Maurice River in this area is *Prohibited* to shellfish harvesting. However, the edge of the nearest shellfish harvest area is located south of the mouth of the Maurice River. On April 21, 2011, water samples were collected at eight sampling stations in the Maurice River from the Maurice River Cove to the Mauricetown Bridge and analyzed for mTec levels. The mTec levels were highest in the Maurice River Cove and off of Bivalve and lowest at the Mauricetown Bridge. These results were consistent with the water

quality results found in the Maurice River and Maurice River Cove during the special study of this area of July 2004 to October 2005 and did not show any impacts to the water quality of this area from the sewage spill.

On August 26, 2011, the State of New Jersey Department of Environmental Protection put into effect a precautionary closure for all shellfish waters in New Jersey due to the approach of Hurricane Irene ‘to assure that the public health is not imperiled by the consumption of shellfish that may be subject to pollution or to any other conditions which may render shellfish dangerous.’ All shellfish waters in the Delaware Bay were closed to shellfish harvesting. Water samples were collected on 9 sampling dates (8/29, 8/30, 8/31, 9/1, 9/2, 9/3, 9/4, and 9/8). On September 8, 2011, water quality showed an improvement in a portion of the Delaware Bay south of a line from Beadon Point to the Cross Ledge abandoned lighthouse and the shellfish waters south of this line were reopened. On September 10, 2011, six monitoring stations were added to the sampling collection in the main channel and in the oyster areas from Ship John Shoal to Benny Sands. Additional water samples were collected on 9/10, 9/12, 9/14, and 9/15. On September 15, 2011, the salinity readings at 14 monitoring stations showed unusually low levels and many readings were outside the tolerance range for oysters (5-30psu). The low salinity was due to the tremendous flow of fresh water from the Delaware River as a result of record precipitation. Additional water samples were collected on 9/17, 9/19, and 9/21. The samples collected on September 21, 2011 showed an improvement in water quality with the samples collected slightly north of Nantuxent Cove and southbound meeting the *Approved* criteria. Additional samples were collected on 9/23 and 9/26. Coliphage and fecal coliform samples on shellfish tissue were collected on September 28, 2011 and the tissue samples were within acceptable levels. Therefore, on September 29, 2011, the Department reopened shellfish harvesting to that portion of the Delaware Bay south of a line from Ben Davis Point, through sampling station s3800F and 3800, and to a point at the state boundary line at Latitude 39 degrees 15 minutes 10.158 seconds N, Longitude -75 degrees 20 minutes 17.038 seconds W. Additional water samples were collected on 9/23 and 9/26. The samples collected on September 26, 2011 showed an improvement in water quality in the Upper Delaware Bay, with samples meeting the *Approved* criteria. Coliphage and fecal coliform samples on shellfish tissue were collected on October 3, 2011 and the tissue samples were within acceptable levels. Therefore, on October 4, 2011, the Department reopened shellfish harvesting to the entire Delaware Bay. Having determined through sample monitoring that all the waters of the Delaware Bay were now safe for the harvesting of shellfish, all of these shellfish waters were returned to their prior classification.

On February 21, 2012, a sewage spill was reported for the area in front of a residence at 1137 Roberts Boulevard in Vineland City, Cumberland County. According to the report sent to WM&S’ Bureau of Marine Water Monitoring, this spill started at 8:00 PM on this date and approximately 25 gallons/minute of sewage spilled into the storm drain at this location when a break in the 18” main caused the sewage to overflow into the storm drain and flow into the Maurice River. The shellfish classification of the Maurice River in this area is *Prohibited* to shellfish harvesting. The repairs and

cleanup of this sewage spill were reported as pending on this date and time (2/21/2012, 9:48 AM) this report was received by the WM&S' Bureau of Marine Water Monitoring. When I telephoned and spoke to a representative of the Landis Sewage Authority on February 21, 2012, I was told that the 18" main would be repaired by the next morning. When I telephoned back on February 22, 2012, I was told that the 18" main was repaired at 10:00 AM and the cleanup of the area was underway. In this period of time (14 hours) and a spill rate of 25 gallons/minute, a total of 21,000 gallons of sewage spilled into the storm drain and the Maurice River at this location. The edge of the nearest shellfish harvest area is located south of the mouth of the Maurice River in *Approved* shellfish waters and there was no evidence of an impact to the water quality of this remote shellfish growing area.

On February 23, 2012, a discharge of oil from an oil tank was reported for the area of the Paulsboro Refining Company facility in Paulsboro, NJ, in Gloucester County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 157,000 barrels (6.6 million gallons) of oil was discharged into the emergency containment area of the refinery at this location at 1:30 PM of this date when a refinery personnel noticed the oil storage tank had a leak at its base and was leaking into the emergency containment area at this site near the Delaware River. According to a DEP Release account of this spill, the oil tank is designed to hold approximately 286,000 barrels (12 million gallons) of oil and the emergency containment area is designed to hold 377,000 barrels of oil. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. According to the DEP Release, emergency crews were applying foam to the oil in the containment area to reduce vapors and the refinery was pumping the oil from the tank and the containment area into other facilities on-site. The activities were expected to continue throughout the night. The NJDEP was monitoring the cleanup efforts for this spill and the spill was not expected to impact the waters of the Delaware River. The DEP's Bureau of Emergency Response, the New Jersey Office of Emergency Management, the Gloucester County Health Department, the U.S. Coast Guard, and refinery personnel were all involved in the response efforts. The spill report listed the spill as contained and the cleanup of the spill in process for this spill on February 23, 2012.

On March 15, 2012, a sewage spill was reported for the area of 355 Fowser Road at the Millville Sewage Authority Wastewater Treatment Facility near the Maurice River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 19,000 gallons of sewage was discharged into the Maurice River at this location. The shellfish classification of the Maurice River in this area is *Prohibited* to shellfish harvesting. However, the edge of the nearest shellfish harvest area is located south of the mouth of the Maurice River. On this date, this sewage discharge was reported as terminated at 10:00 AM and some of the sewage was cleaned up. However, most of the sewage went into the Maurice River at this location.

On March 20, 2012, a sewage sludge spill was reported for the area of 69 Jefferson Lane at the Logan Township Municipal Utilities Authority Wastewater Treatment Facility near the Maurice

River in Logan Township, NJ in Gloucester County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 1,000 gallons of sewage sludge was discharged into the wetlands and surrounding area near this location on March 20, 2012 at 4:00AM due to a holding tank overflow. The spill report also states that approximately 200 gallons of this sewage sludge was directly discharged into the wetlands but the cause was still under investigation. There is no shellfish classification for the Delaware River near Trenton because shellfish are not harvested in these waters. In the Delaware River, the shellfish waters closest to this area are the *Restricted* shellfish waters that begin immediately to the south of Artificial Island. The spill was terminated and the cleanup was in progress when this spill report was received by the WM&S' Bureau of Marine Water Monitoring on March 20, 2012 at 7:18AM.

On June 25, 2012, a raw sewage spill was reported for the area of 1502 Lamberton Road at the Trenton Sewer Utility Sewage Treatment Facility near the Delaware River in Trenton, Mercer County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, this spill started at 8:30 AM on this date when approximately 45,000 gallons of raw sewage was discharged into the Delaware River near Trenton. There is no shellfish classification for the Delaware River near Trenton because shellfish are not harvested in these waters. In the Delaware River, the shellfish waters closest to this area are the *Restricted* shellfish waters that begin immediately to the south of Artificial Island. This sewage spill was reported as terminated at 10:52 AM on this date.

On October 16, 2012, a sewage spill was reported for the area of 6 Westwood Drive near Mantua Creek in Mantua Township. According to the report sent to WM&S' Bureau of Marine Water Monitoring, this spill started at 6:50 AM on this date when approximately 45,000 gallons of sewage spilled due to a pump failure and line blockage which caused the sewage to overflow from a manhole and flow into Mantua Creek, which eventually flows into the Delaware River near Paulsboro. There is no shellfish classification for Mantua Creek or the Delaware River near Paulsboro because shellfish are not harvested in these waters. In the Delaware River, the shellfish waters closest to this area are the *Restricted* shellfish waters that begin immediately to the south of Artificial Island. This sewage spill was reported as terminated at 8:30 AM on this date and the cleanup of the area was in progress at the time this report was received.

On October 29, 2012, the State of New Jersey Department of Environmental Protection put into effect a precautionary closure for all shellfish waters in New Jersey due to the approach of Hurricane Sandy 'to assure that the public health is not imperiled by the consumption of shellfish that may be subject to pollution or to any other conditions which may render shellfish dangerous.' All shellfish waters in the Delaware Bay were closed to shellfish harvesting. Water samples were then collected in all the marine waters throughout the State of New Jersey. On November 12, 2012, the Department reopened shellfish harvesting to the Delaware Bay in Cumberland and Salem Counties due to an improvement in the water quality. On November 15, 2012, water quality showed an improvement in all of the waters of Atlantic and Cape May Counties from Little Egg Inlet to Cape May Point and the shellfish waters in the Delaware Bay – Cape Shore area were reopened. On

April 15, 2013, after having determined through sample monitoring that all the waters of the State of New Jersey were safe for the harvesting of shellfish, all of these shellfish waters were returned to their prior shellfish classification.

On November 30, 2012, a discharge of 1086 vinyl chloride was reported for the area of the 230 East Jefferson Street in Paulsboro Borough, NJ, in Gloucester County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an unknown amount of 1086 vinyl chloride was discharged into Mantua Creek at this location at 7:04AM of this date after the collapse of a rail bridge caused five (5) tanker cars from a train to fall into Mantua Creek at this site and the crash ruptured the tanker cars which caused the spill. Mantua Creek eventually flows into the Delaware River and the Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. The spill report listed the spill as not contained and a HAZMAT crew at the scene on November 30, 2012 at 7:56AM. Paulsboro residents within a half mile radius of this spill site were evacuated from this area. All of the rail crew were accounted for and there were no fatalities from the crash. The WM&S' Bureau of Marine Water Monitoring was never notified when this spill was terminated and cleaned up.

On July 28, 2013, a discharge of raw sewage was reported for the area of 237 J Street in Carneys Point Township, NJ, in Salem County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an unknown amount of raw sewage was discharged into the road, a storm drain, and the wetlands at this location at 2:00PM of this date when a heavy rainfall caused his street to flood with raw sewage and the raw sewage was draining into the storm drain and nearby wetlands area near homes in this area. The storm drains in this area all flow into the Delaware River. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. No cleanup or termination of this spill was received by the WM&S' Bureau of Marine Water Monitoring when this report was received on July 28, 2013 at 4:35PM. The WM&S' Bureau of Marine Water Monitoring was never notified when this spill was terminated and cleaned up. However, the caller that reported this spill requested that the department collect water samples near this spill to determine the impact to the water quality, as per a request by Senator Sweeney.

On December 29, 2013, a discharge of waste oil was reported for the area of Sunoco Logistics at 1240 Crown Point Road in Westville Borough, NJ, in Gloucester County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an unknown amount of waste oil was discharged into the Delaware River at this location at 3:30PM of this date when a dock sump discharged waste oil into the Delaware River at this site causing the spill. According to the spill report, an oil sheen 20 feet long by 5 feet wide was seen in the Delaware Bay at the site of this spill. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. The spill report listed the spill as terminated and in the process of being cleaned up on December 29, 2014 at 3:54PM.

On January 14, 2014, a discharge of fuel oil was reported from the area of 201 Water Street in Gloucester City, NJ, in Camden County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an estimated 300 gallons of fuel oil was discharged into the Delaware River at this location at 8:25AM of this date when an expansion tank leaked at this site causing the spill into the Delaware River. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. The spill report listed the spill as not contained and absorbent pads and booms were deployed only on land at the location of this spill on January 14, 2014 at 8:40AM. The WM&S' Bureau of Marine Water Monitoring was never notified when this spill was finally cleaned up.

On April 24, 2014, a discharge of sewage was reported for the area of the intersection of Clements Bridge Road and Route 42 in Deptford Township, in Gloucester County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 1,000 gallons of sewage was discharged into Timber Creek at this location at 1:00PM on this date and a broken 12" forced main at this site caused the spill. Timber Creek eventually flows into the Delaware River and the Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. This spill report lists the spill as continuous with a spill rate of 2GPM and repairs pending to the sewer line on April 24, 2014 at 2:25PM. The WM&S' Bureau of Marine Water Monitoring was never notified when the repairs were completed.

On May 16, 2014, a discharge of sewage was reported for the area of the Arch Street Pump Station in Camden, NJ, in Camden County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an estimated 1,000 gallons of sewage was discharged into the Maurice River at this location sometime in the morning of this date after a pump station was reported as shut down due to a heavy rainfall. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. No cleanup or termination of this spill was received by the WM&S' Bureau of Marine Water Monitoring.

On June 10, 2014, a discharge of sewage was reported for the area of the Arch Street Pump Station in Camden, NJ, in Camden County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an unknown amount of sewage was discharged into the Maurice River at this location at 6:30PM on this date after a sewage bypass was reported after a heavy rainfall. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. The cleanup of this spill was not reported but this spill was reported as terminated on June 10, 2014 at 10:40PM.

On June 28, 2014, a small two-seat airplane crash landed in the marsh near 454 Fort Mott Road, in Pennsville Township, NJ, Salem County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 50 gallons of oil was discharged into this marsh and eventually

into the Maurice River at this location at 11:04 AM on this date due to the airplane crash. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. The cleanup of this spill was reported as pending the investigation of the crash at the time this spill report was received on June 28, 2014 at 1:16PM.

On September 9, 2014, a discharge of sewage was reported for the area of the Netting Facility at the intersection of Front Street and Eire Street in Camden, NJ, Camden County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an unknown amount of sewage was discharged into the Delaware River at this location at 2:00PM on this date after a dry weather overflow caused sewage to be discharged through the netting facility and into the Delaware River. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. This spill was reported as not contained or cleaned up when this spill report was received on September 9, 2014 at 2:18PM.

On November 26, 2014, a discharge of sewage was reported for the area of the Arch Street Pump Station in Camden, NJ, Camden County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an unknown amount of sewage was discharged into the Maurice River at this location at 1:15PM on this date after the Arch Street Pump Station shut down due to a heavy rainfall and sewage was bypassed into the Delaware River. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. This spill was reported as contained and in the process of being cleaned up when this spill report was received on November 26, 2014 at 2:26PM.

On March 31, 2015, a discharge of sewage (secondary effluent) was reported for the area of 355 Fowser Road at the Millville Sewage Authority Wastewater Treatment Facility near the Maurice River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 187,500 gallons of sewage (secondary effluent) was discharged into the Maurice River at this location at 2:00 AM due to a failure of the UV gate. The shellfish classification of the Maurice River in this area is *Prohibited* to shellfish harvesting. However, the edge of the nearest shellfish harvest area is located south of the mouth of the Maurice River. This sewage (secondary effluent) discharge was reported as terminated at 5:00 AM on this date when the UV gate was reset.

On October 2, 2015, the State of New Jersey Department of Environmental Protection put into effect a precautionary closure for all shellfish waters in New Jersey due to the approach of a nor'easter 'to assure that the public health is not imperiled by the consumption of shellfish that may be subject to pollution or to any other conditions which may render shellfish dangerous.' All shellfish waters in the Delaware Bay were closed to shellfish harvesting. On October 5, 2015, all of the shellfish waters in New Jersey were returned to their previous existing shellfish classification and reopened.

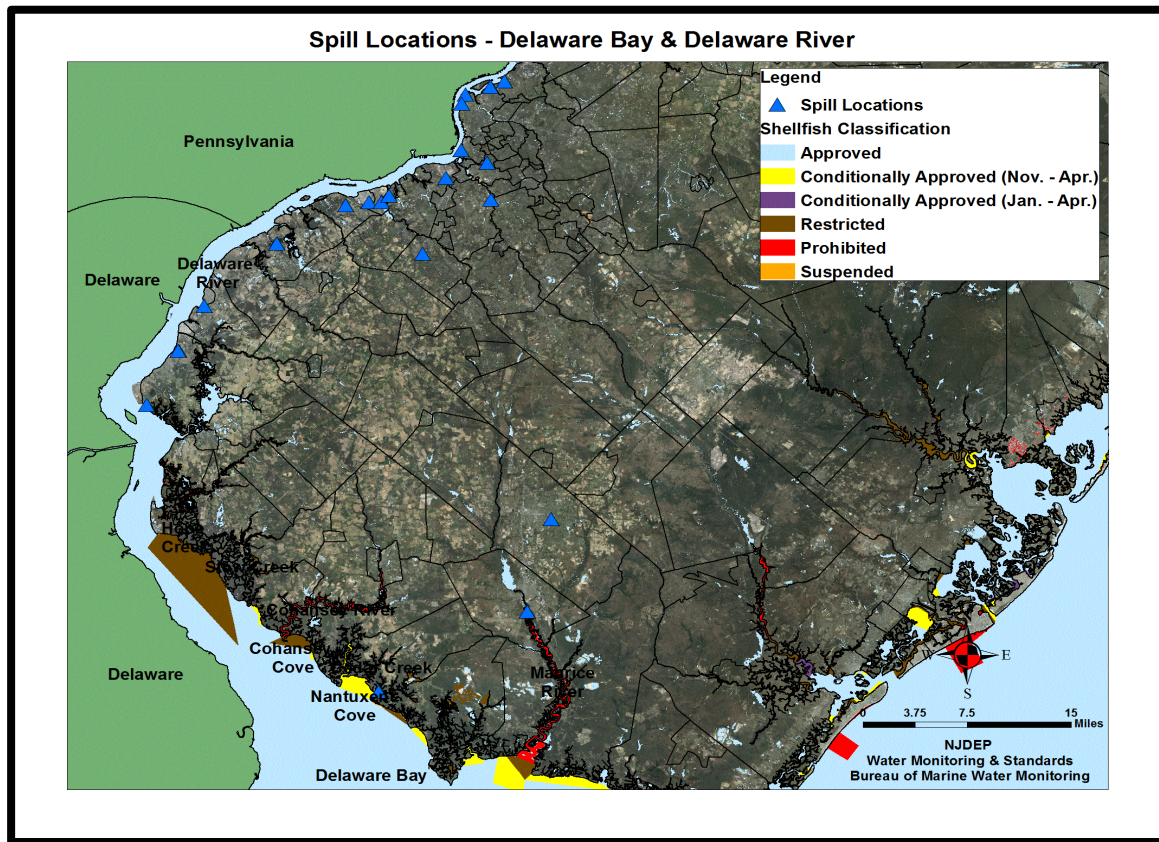
On February 24, 2016, a discharge of grease was reported for the area of 355 Fowser Road at the Millville Sewage Authority Wastewater Treatment Facility near the Maurice River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 15 gallons of grease was discharged onto the land at this location at 3:25 PM due to a blockage. The shellfish classification of the Maurice River in this area is *Prohibited* to shellfish harvesting. However, the edge of the nearest shellfish harvest area is located south of the mouth of the Maurice River. This spill was reported as terminated and the cleanup of the area was complete at 4:55PM on this date.

On February 25, 2016, a discharge of sewage effluent was reported for the area of 400 North Randolph Avenue in Cinnaminson Township at the Cinnaminson Sewage Authority Wastewater Treatment Facility near the Delaware River in Riverton Borough, NJ, Burlington County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 2,377,000 gallons of sewage effluent was discharged onto the Delaware River at this location at 11:59 PM due to a overflow caused by heavy rain. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. This spill was reported as not contained at the time this report was received on February 26, 2016 at 12:29AM, and, after an unsuccessful attempt was made to contact the reporting agency, this report writer heard nothing further about this spill.

On February 25, 2016, a discharge of sewage effluent was also reported for the area of North School Street in Greenwich Township at the Greenwich Township Wastewater Treatment Facility near the Delaware River in Greenwich Township, NJ, Gloucester County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 10,890,000 gallons of sewage effluent was discharged onto the Delaware River at this location at 11:59 PM due to a overflow caused by heavy rain. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. This spill was reported as not contained at the time this report was received on February 26, 2016 at 3:32PM, and, after an unsuccessful attempt was made to contact the reporting agency, this report writer heard nothing further about this spill.

On April 1, 2016, a discharge of sewage was reported for the area of the Arch Street Pump Station in Camden, NJ, Camden County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, an unknown amount of sewage was discharged into the Delaware River at this location at 8:00PM on this date after the Arch Street Pump Station shut down due to a heavy rainfall and sewage was bypassed through a netting system into the Delaware River. The Delaware River has no shellfish classification for the area of this spill because this area is far north of the shellfish harvesting area which begins south of Artificial Island. This spill was reported as not contained or cleaned up when this spill report was received on April 1, 2016 at 8:07PM.

On the dates of these spills into the Delaware River when the spills had exceeded 1,000,000 gallons of sewage effluent, there were no observable impact on the water quality at the sampling stations in the lower Delaware Bay.



Naturally Occurring Pathogens

The bacterium *Vibrio parahaemolyticus* (*Vp*) and *Vibrio vulnificus* (*Vv*) are naturally occurring inhabitants found in coastal waters that cause illness from eating infected raw oysters, clams, and mussels. They are not related to pollution, which means that traditional controls for shellfish sanitation related to growing water classification are marginally effective. Instead, the occurrence of these pathogens in elevated levels appears to be related to the interaction of environmental variables such as temperature, salinity, fresh water inflow to the bay and tidal flushing. The *Vp* bacteria thrives under warm temperatures and is linked to raw oysters harvested and consumed during the summer months. Symptoms of *Vp* illness include diarrhea, nausea, vomiting, abdominal cramps, and in some cases, fever and chills. *Vv* produces a rapidly fatal septicemia and wound contact with seawater or shellfish can also lead to infection (NJDEP, 2015).

Every State from which shellfish are harvested is required to conduct a *Vibrio* risk evaluation annually. This evaluation considers the interaction of environmental variables such as temperature, salinity, fresh water inflow to the bay and tidal flushing, including seasonal variations in these

factors to determine whether the risk of *Vibrio* infection from the consumption of oysters harvested from an area is reasonably likely to occur. Based on this assessment, a *Vp* Management Plan for control measures was developed for New Jersey in January 2010, and put into effect in June 2010.

The *Vp* Management Plan serves as a document by which the Department establishes shellfish harvest control measures, which can include restrictions on the hours of the harvest of shellfish as per the National Shellfish Sanitation Program (NSSP), requirements to minimize the growth of the pathogen and consequently reduce the risk of illness for the protection of public health. The requirements implemented through the *Vp* Management Plan were developed through consultation and cooperation with the New Jersey Department of Health and Senior Services, (DHSS), the NJDEP Bureaus of Marine Water Monitoring, Division of Fish & Wildlife, Shellfisheries, and Marine Law Enforcement; and the U.S. Food and Drug Administration, (FDA), along with New Jersey's shellfish industry.

In 2012, an intensive study of *Vp* in the oysters harvested in the Delaware Bay was undertaken. Two sampling stations (Delaware Bay – Cape Shore and Delaware Bay - Rutgers Laboratory) were located adjacent to this shellfish growing area in DB2 in Middle Township, Cape May County. In 2013, the sampling station at the Rutgers Laboratory was dropped, and the focus shifted to the Delaware Bay – Cape Shore *Vp* sampling station for intertidal sampling and the stations from Cohansey to New Beds for subtidal sampling.

In 2013, oyster tissue samples were collected at the intertidal *Vibrio parahaemolyticus* (*Vp*) sampling stations at the Delaware Bay Cape Shore Atlantic Capes Fisheries shellfish beds in the adjacent growing area of DB2. On 15 dates in 2013 (6/17, 6/18, 6/19, 6/20, 7/16, 7/17, 7/18, 7/29, 7/30, 7/31, 8/1, 8/12, 8/13, 8/14, and 8/15), *Vibrio parahaemolyticus* oyster tissue results were very high (ranging from 1,000 on 8/13 to 23,000 on 6/19). There were no closures of shellfish waters for the Delaware Bay Remote area or the Delaware Bay - Cape Shore area in 2013.

Also in 2013, oyster tissue samples were collected at the subtidal *Vp* sampling stations in the Shell Rock and Nantuxent sampling beds. On seven (7) dates in 2013 (6/24, 7/15, 7/22, 7/29, 8/5, 8/12, and 8/26), *Vp* oyster tissue results were very high (ranging from 1,200 on 6/24 and 8/26 to 4,900 on 7/22).

On July 19, 2013, the DEP issued a suspension of the oyster harvest from the Shell Rock oyster bed in Shellfish Growing Area DB1 for the Delaware Bay. This suspension was the result of two reported cases of the naturally occurring pathogen *Vp* in Ocean City, Maryland. These *Vp* illnesses were attributed to the consumption of raw oysters harvested from the Shell Rock oyster bed in the Delaware Bay, New Jersey. Based on the results from the analysis of shellfish tissue samples, no additional reported illnesses, and changes in environmental factors, this closure was lifted on August 15, 2013.

In 2014 the WM&S' Bureau of Marine Water Monitoring, Leeds Point Laboratory added the capability to analyze for both thermostable direct hemolysin (TDH) and TDH-related hemolysin (TRH) virulent strains as well as for total *Vp* by both PCR and the direct plating methods. The study also collected samples from Great Bay to study *Vp* samples from different salinity waters.

In 2014, oyster tissue samples were collected at the subtidal *Vp* sampling stations in the Cohansey to New Beds *Vibrio* sampling beds on a weekly basis from May through August. Some oysters were immediately iced, some were kept unrefrigerated with shading for 6 hours and other oysters were kept unrefrigerated with shading for 7 hours. Data showed that levels for all strains of *Vp* (*tlh*, *tdh*, *trh*) were consistently low when removed from the water, and climbed, as expected, when subjected to time without refrigeration. Monitoring data indicated that the levels for all strains of *Vp* in oyster tissue were within expected ranges. Shell temperatures and shaded air temperatures were measured for all post-harvest handling. The data showed that the shell temperature was much greater than the air temperature from mid-June to mid-July, which also matched with the time frame of historic illness reports. The data from the 2014 *Vp* study was used to shift the harvest hours for 2015, by changing the month of 6 hours from harvest to refrigeration from mid-June to mid-July. The data also showed that the rest of the *Vp* oyster harvest can continue with 7 hours from harvest to refrigeration, so overall hours of harvest for the season were not changed. The intertidal (*Vp*) sampling beds (Delaware Bay Cape Shore Atlantic Capes Fisheries) in this shellfish growing area were dropped from the sampling schedule.

In 2014, there were two confirmed illnesses of *Vp* attributed to oysters harvested in the Delaware Bay. The first case of *Vp* illness was from oysters harvested from the Shell Rock oyster beds and confirmed on June 14, 2014, and the second case of *Vp* illness was from oysters harvested from the Cohansey oyster beds on July 18, 2014 and confirmed on July 25, 2014. There was also an unconfirmed illness of *Vibrio fluvialis* attributed to oysters harvested in the Benny Sands, Cohansey, or Shell Rock oyster beds in the Delaware Bay on July 23, 2014. These confirmed illnesses did not result in a *Vibrio* outbreak or shellfish closure.

In 2015, an intensive study of *Vp* in the oysters harvested in the Delaware Bay was undertaken. Oyster tissue samples were collected at the subtidal *Vp* sampling beds in the adjacent waters of Shellfish Growing Area DB1. On 18 dates in 2015 (once per week between May 5 to August 31), *Vp* oyster tissue results were analyzed using the PCR and direct plating method for *Vp* (*tlh*, *trh*, and *Tdh*) and PCR for *Vibrio vulnificus*. *Vibrio* was studied in out-of-water initial levels immediately onto ice (once a month), after ice slurry for 10 minutes after 1, 3, and 5 hours of shading on deck, and 5 hours with overnight refrigeration. Meat and shell temperatures were recorded for each step. Temperature buttons were placed in oysters to study cooling effectiveness and time to below temperature of 50 degrees F of slurry and refrigeration. Water quality readings (temperature, salinity, pH, and dissolved oxygen) were taken with each sample collected. The total of results of all parameters was 1,110.

On June 23-24, 2015, there was one confirmed illness of *Vp* attributed to oysters harvested in the Delaware Bay. This illness was from oysters harvested in the Shell Rock oyster bed and was attributed to temperature abuse during post-harvest handling. This confirmed illness did not result in a *Vibrio* outbreak or shellfish closure.

In 2016, the sampling of *Vibrio* in the oysters harvested in the Delaware Bay was continued, and a background study of *Vibrio* in hard clams was also started for random back bay areas of New Jersey. In the Delaware Bay, oyster tissue samples were collected at the Shell Rock and Ship John subtidal *Vibrio* sampling beds in this shellfish growing area. *Vibrio* was sampled on 12 dates (once per week) between June 6 to August 22. *Vibrio* was analyzed using qPCR and plate method for *Vp* (tlh, trh, and Tdh) and qPCR for *Vv*. Water quality readings (temperature, salinity, pH, and dissolved oxygen) were also taken with each sample. A total of 84 samples were analyzed for *Vp* and *Vv* in 2016.

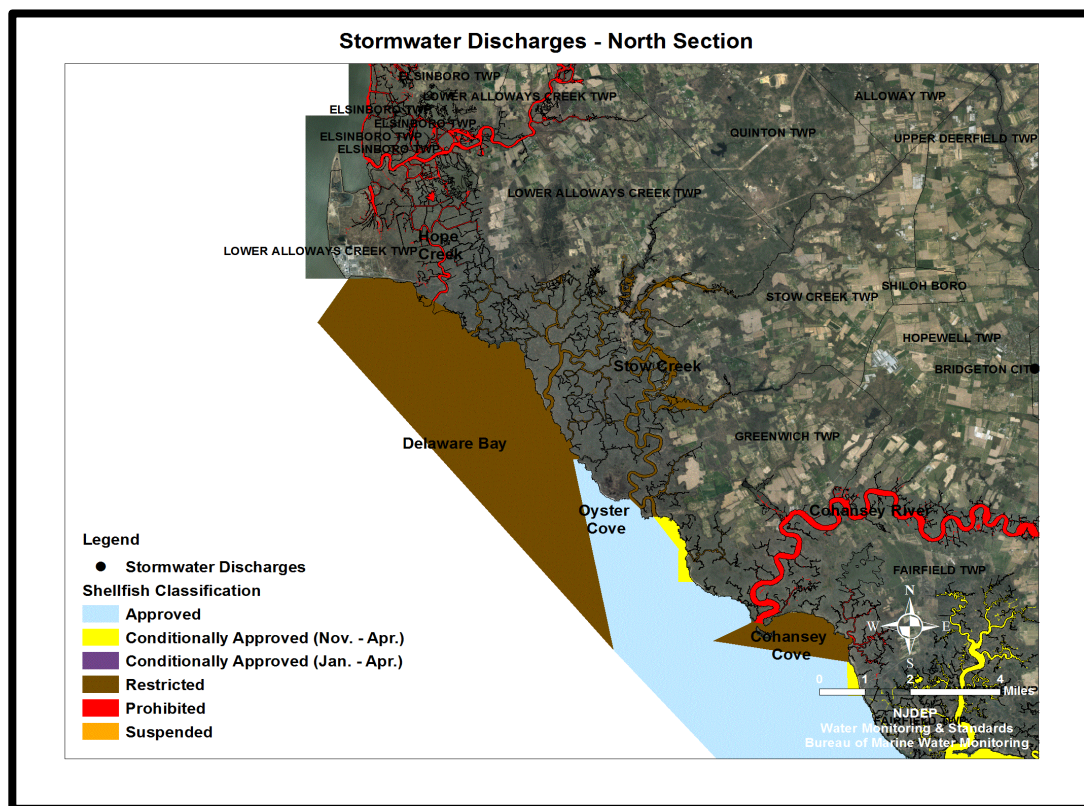
In 2016, there were sporadic illnesses of *Vp* from mixed batches of oysters (multiple sources) and some of these sources could have been oysters harvested in the Delaware Bay (not confirmed) but none of these illnesses resulted in an outbreak or closure.

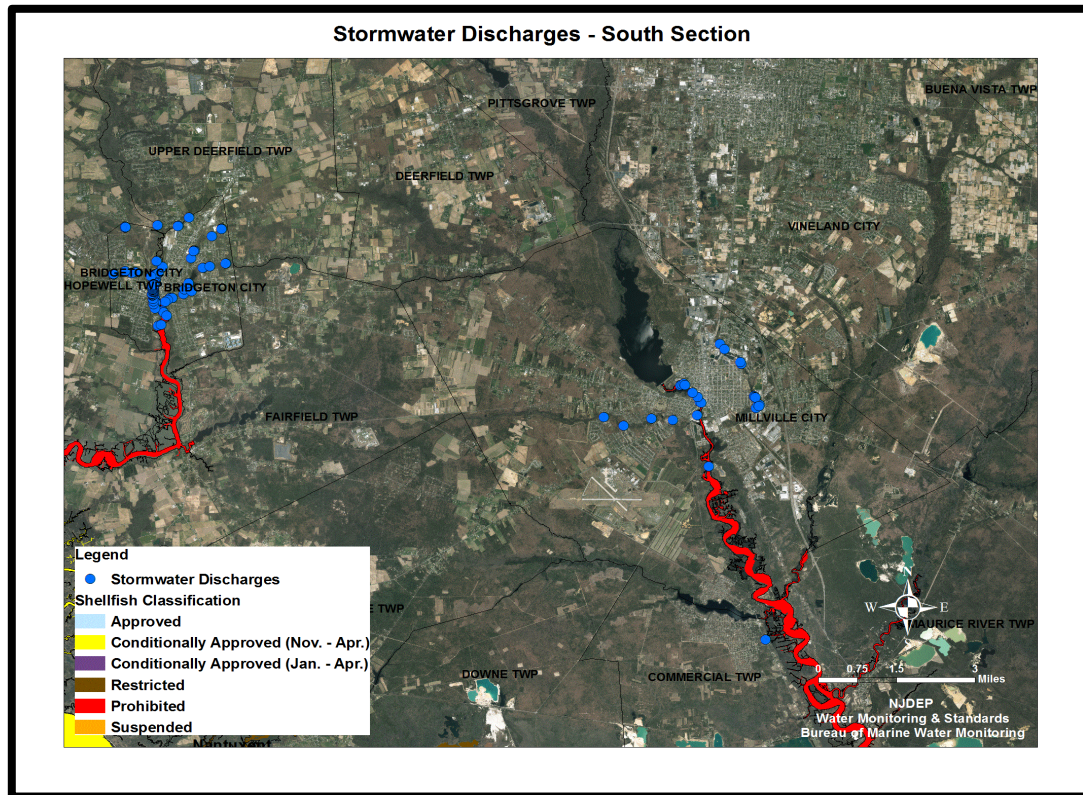
Stormwater Discharges

Stormwater runoff is generated when precipitation from rain and snowmelt flows over land or impervious surfaces and does not percolate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the discharge is untreated. run-off. The typical pollutants that are associated with stormwater run-off are bacterial, heavy metals, pesticides, herbicides, chlorides, petroleum, and nutrients (NJStormwater.Org). Most of the stormwater outfalls within this growing area are near residential and urbanized districts.

In the City of Millville, there are 25 stormwater discharges that drain into the Maurice River. Commercial Township only has one (1) stormwater discharge that drains into the Maurice River. The City of Bridgeton has 102 stormwater discharges that drain into the Cohansey River. These stormwater outfalls drain into the waters of this shellfish growing area and have the potential to impact the water quality of this area. The stormwater discharges into the waters of the north part of this shellfish growing area were not available at the date this report was written.

Since these stormwater outfalls usually discharge into the nearby creeks and lagoon systems, the shellfish harvesting is condemned in all lagoon systems.





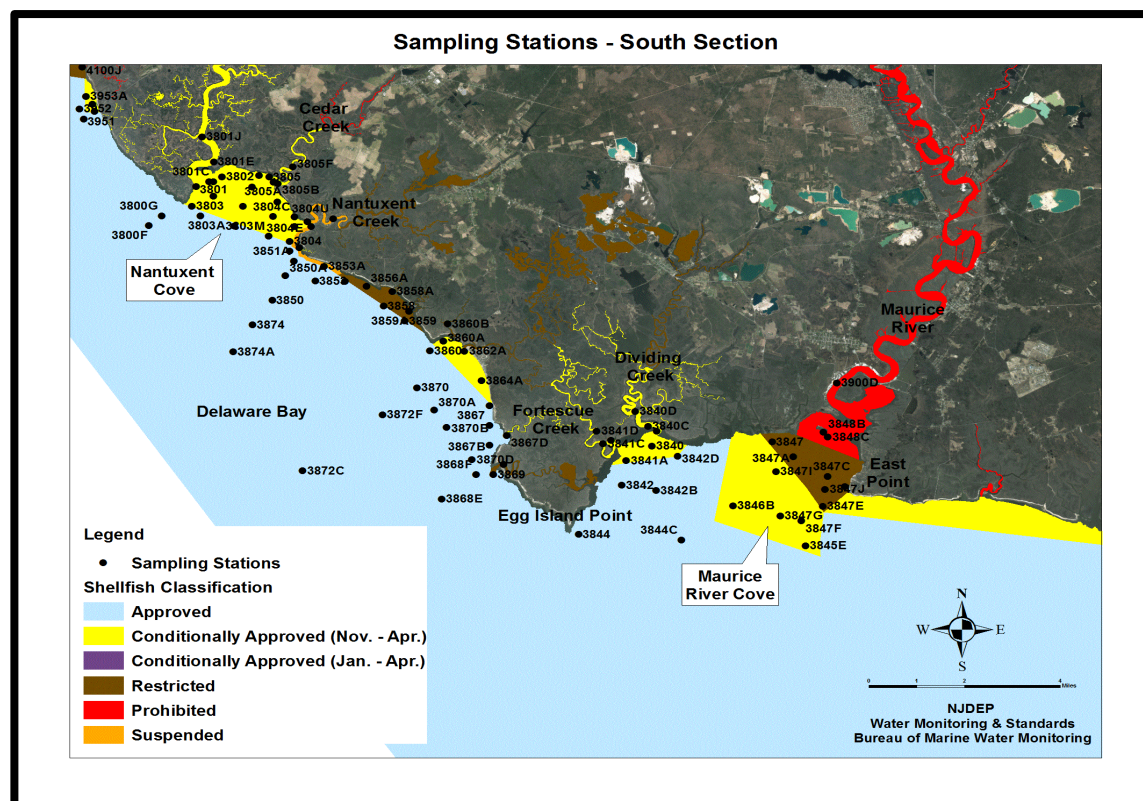
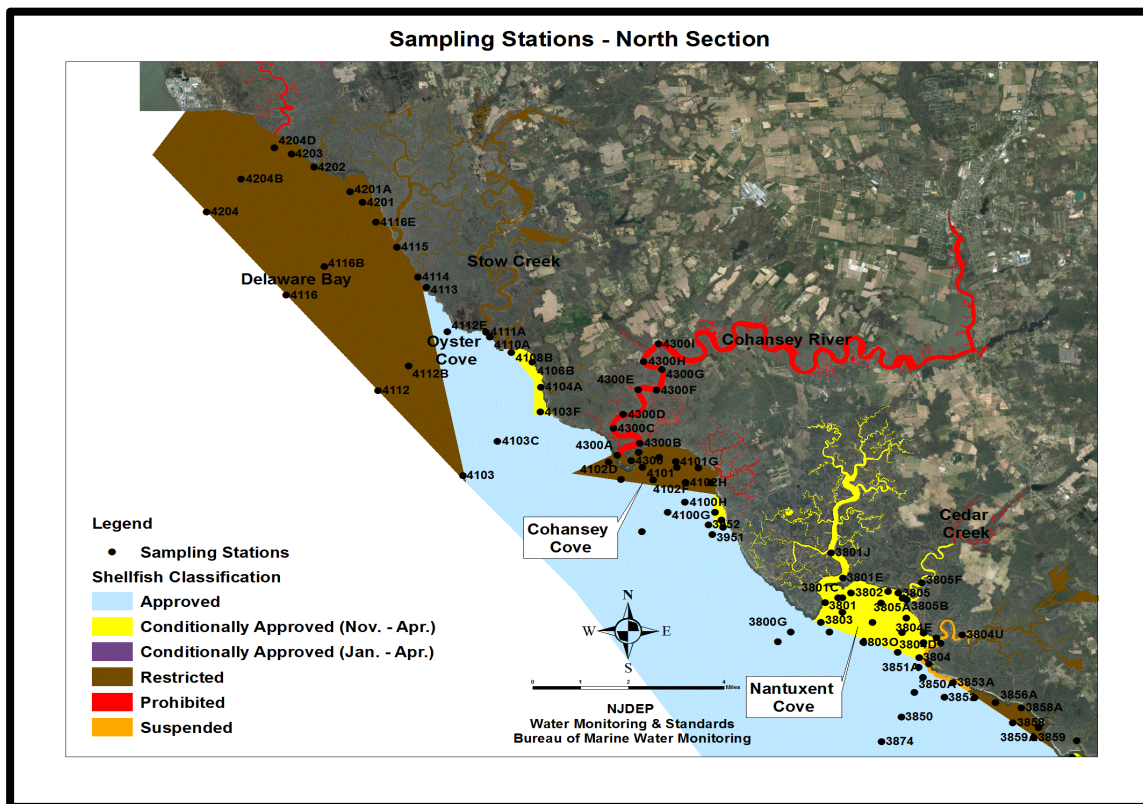
WATER QUALITIES STUDIES

Sampling Strategy

The State Shellfish Control Authority has the option of choosing one of two water monitoring sampling strategies for each growing area. For additional information on the types of sampling strategies, see the *Shellfish Growing Area Report Guidance Document, 2011*. This shellfish growing area could possibly be impacted by the discharges from the sewage treatment facilities in this area or combined sewer overflows; therefore, it was sampled under the Adverse Pollution Condition (APC) Strategy.

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 2005). From 2011 through 2017, approximately 5,507 water samples were collected for fecal coliform bacteria from 143 monitoring stations. The locations of these stations are shown in the figures on the next page. These samples were analyzed by using the fecal coliform mTEC method (APHA, 1970). Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish*, Revision 2015. Data management and analysis was accomplished using database applications developed for the Bureau. Mapping of pollution data

was performed with the Geographic Information System (GIS: ARC map).



Bacteriological Quality

This report includes data analyzed from January 2011 to February 2017. This shellfish growing area is composed of seven assignment areas, (Assignments 315, 327, 332, 357, 362, 377, and 378) and is sampled using the Adverse Pollution Condition (APC) sampling strategy year-round. The preceding two figures show all of the sampling stations for this area. The raw data listings for each sampling station, in accordance with the National Shellfish Sanitation Program (NSSP), are at the end of this report in the Appendix.

Compliance with NSSP APC Criteria

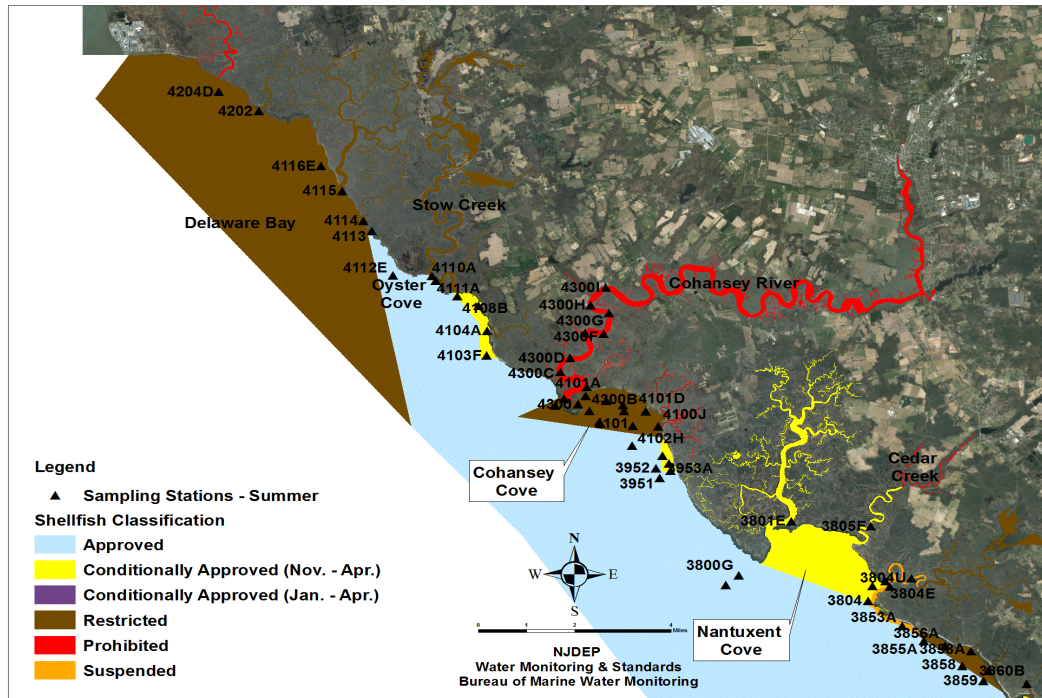
Most of the sampling stations in this shellfish growing area met their existing *Approved*, *Conditionally Approved (November to April)*, *Restricted*, and *Prohibited* shellfish classification criteria, year-round, in the summer, and in the winter. Therefore, most of the sampling stations in this area were in compliance with their existing shellfish classification criteria. However, there was one sampling station (4112E) that exceeded the NSSP shellfish classification criteria for water quality in the *Approved* waters of this shellfish growing area.

Seasonal Effects

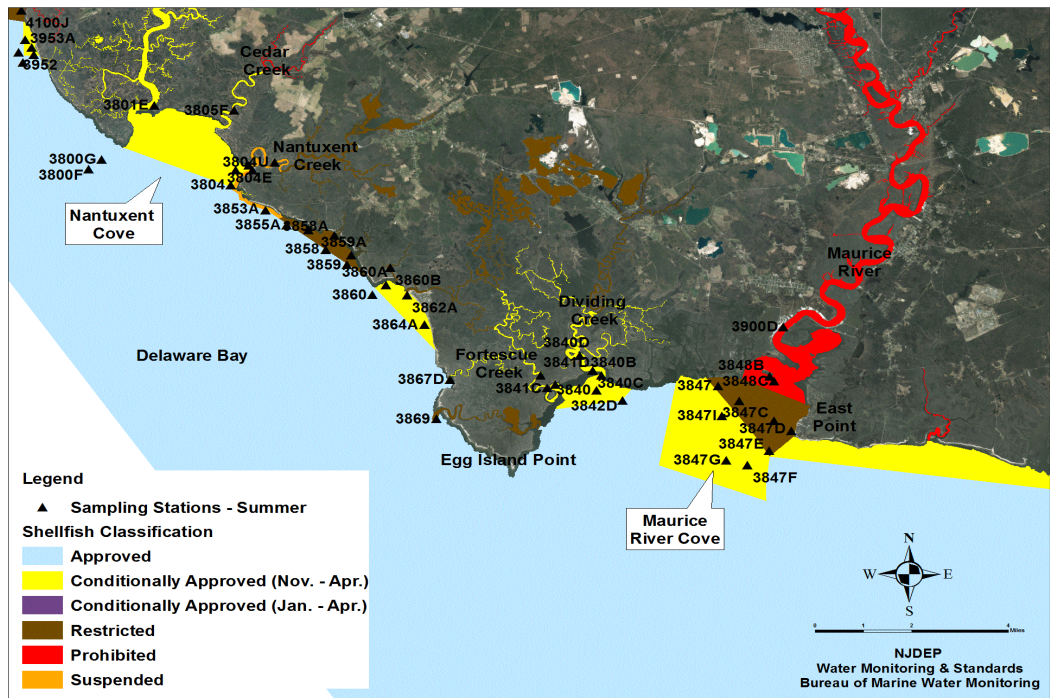
As the earth experiences variations in the tilt of its axis and its revolution around the sun, it goes through seasonal phases of summer, spring, autumn, and winter. These seasonal phases cause much variation in the atmosphere of the earth, resulting in changes in weather patterns. Temperature, precipitation, wind, and the general circulation of the atmosphere have seasonal variations that also affect the marine environment (Ingmanson and Wallace, 1989). Seasonal variation may also be the result of a variety of conditions, including specific agricultural land-use practices, biological activity, stream flow and/or sediment.

To determine whether seasonal variation can influence bacteria counts, WM&S/BMWM uses a t-test to compare the fecal coliform values from samples collected during the summer season versus samples collected during the winter months. Based on the t-test results, eighty one (81) monitoring stations had a t-statistical probability of less than 0.05. All of these monitoring stations show a higher geometric mean during the summer than during the winter. Only Assignment 332 in this shellfish growing area was sampled with a seasonal preference during the summer. The rest of the assignments in this shellfish growing area were sampled year-round with no seasonal preference.

Seasonal Sampling Stations - North Section



Seasonal Sampling Stations - South Section



Rainfall Effects

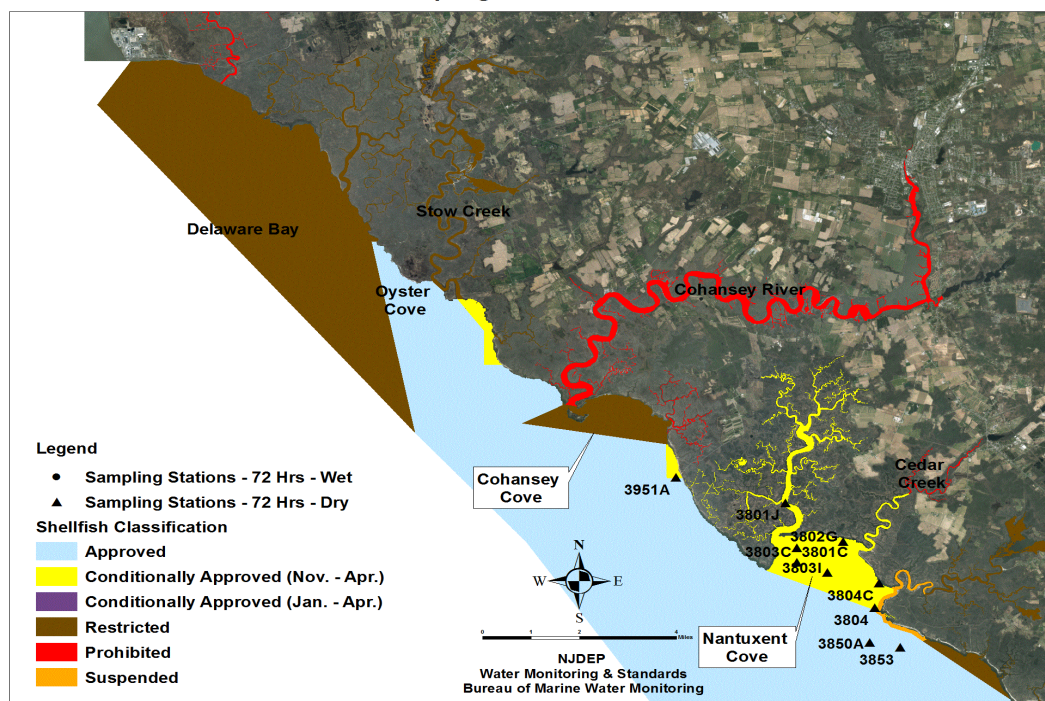
Non-point source pressures on shellfish beds in New Jersey originate in materials that enter the water via stormwater. These materials include bacteria, as well as other waste that enters the stormwater collection system.

Rainfall impacts were assessed by using a t-test to compare the fecal coliform values from water samples collected during wet weather to water samples collected during dry weather from 1/1/2011 to 2/23/2017. The Wet/Dry Statistics were calculated based on a post impact time of 72 hours prior to the day of sampling and a wet/dry cutoff of 0.3 inches of rain. Any rainfall amounts above 0.3 inches are considered to be a wet condition. A sampling station is considered to be impacted by rainfall when the t-statistic probability is 0.05 or less, but not zero. Using these parameters for the rainfall data, fifteen (15) sampling stations showed an impact from rainfall for this shellfish growing area from 1/1/2011 to 2/23/2017.

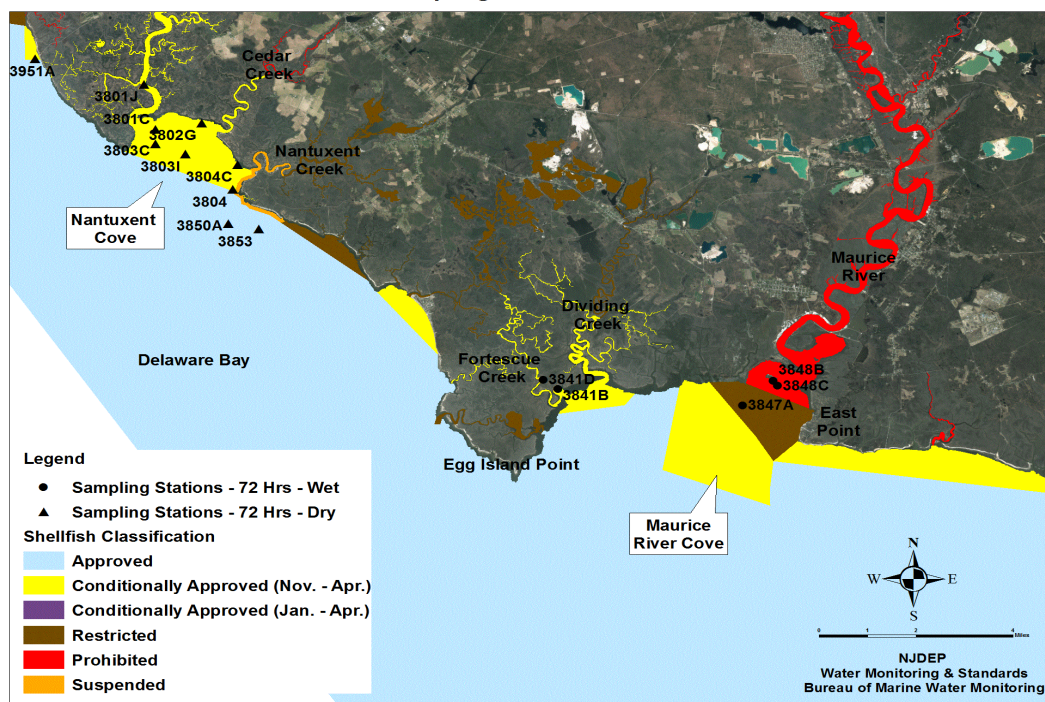
Based on a significant correlation between fecal coliform values from wet/dry data for 1/1/2011 to 2/23/2017, an impact from rainfall was found to occur at the fifteen (15) sampling stations throughout this shellfish growing area. These APC sampling stations are located throughout this shellfish growing area. Five (5) of these rainfall sampling stations (3841B, 3841D, 3847A, 3848B, and 3848C) showed a higher fecal coliform geometric mean during wet conditions, while ten (10) of these rainfall sampling stations (3801C, 3801J, 3802G, 3803C, 3803I, 3804, 3804C, 3850A, 3853, and 3951A) showed a higher fecal coliform geometric mean during dry conditions. However, the fecal coliform levels still meet the existing *Approved*, *Conditionally Approved (November to April)*, *Restricted*, and *Prohibited* shellfish classification criteria for these sampling stations in these shellfish waters. Since the water quality in this shellfish growing area is slightly impacted by rainfall but not enough to affect the shellfish classification, this area will continue to be sampled using the Adverse Pollution Condition (APC) strategy.

The Bureau of Marine Water Monitoring has begun to identify particular stormwater outfalls that discharge excessive bacteriological loads during storm events. In some cases, specific discharge points can be identified. When specific outfalls are identified as significant sources, the Department works with the county and municipality to further refine the source(s) of the contamination and implement remediation activities.

Rainfall Sampling Stations - North Section



Rainfall Sampling Stations - South Section

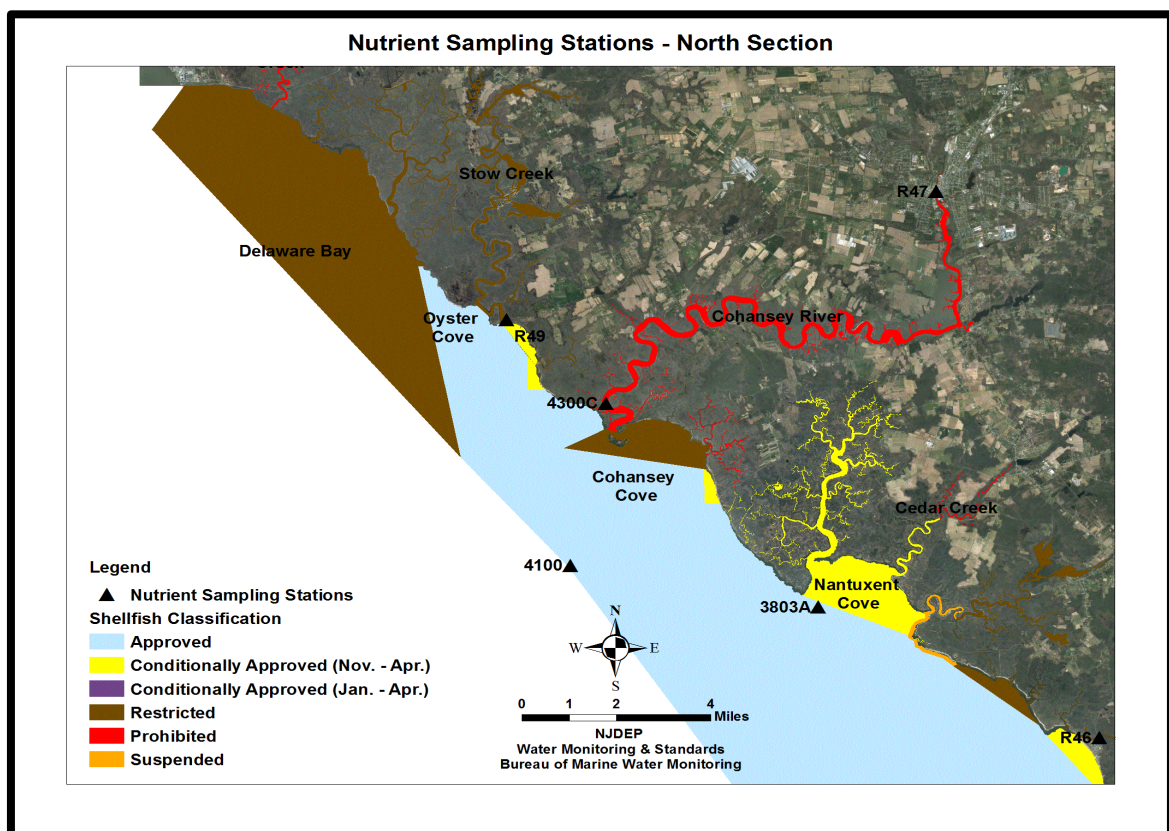


RELATED STUDIES

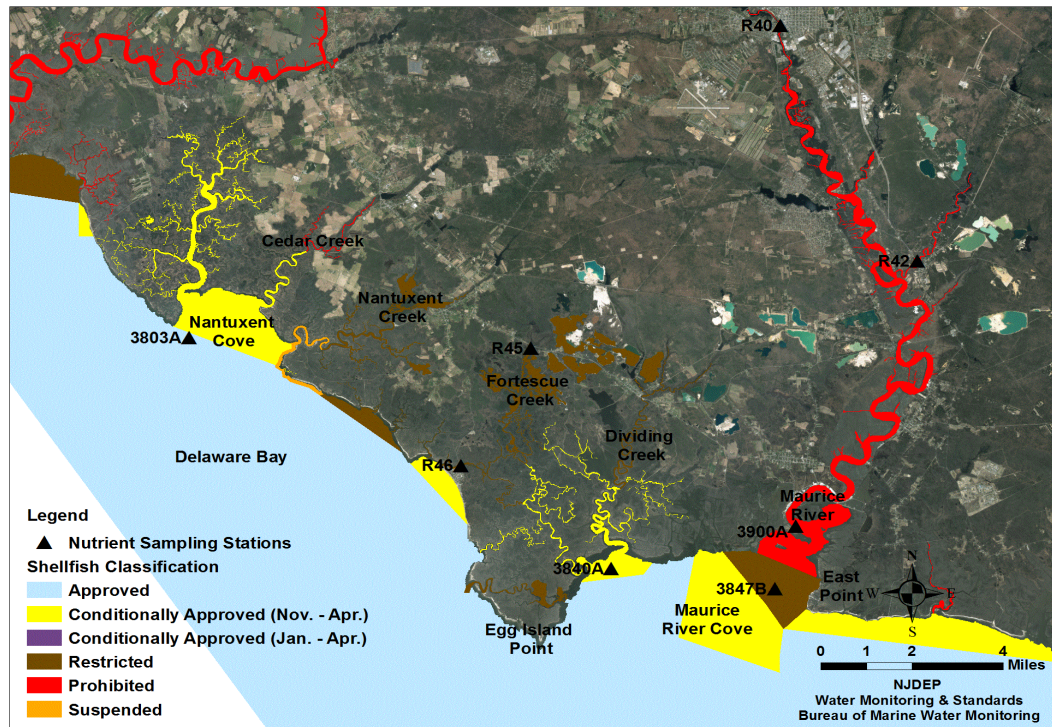
Nutrients

In this growing area, twelve (12) nutrient monitoring sites were sampled under the estuarine monitoring program. At these nutrient monitoring sites, various parameters were measured including water temperature, salinity levels, secchi depth, total suspended solids, dissolved oxygen levels, ammonia levels, nitrate and nitrite levels, orthophosphate levels, total nitrogen levels, and the inorganic nitrogen to phosphorus ratios. Between 2011 and 2017, water samples were analyzed for these nutrient parameters at these nutrient stations in this growing area. For full nutrient assessment, see the Estuarine & Coastal Water Quality Reports, available electronically at:

<http://www.state.nj.us/dep/bmw/reports.htm>



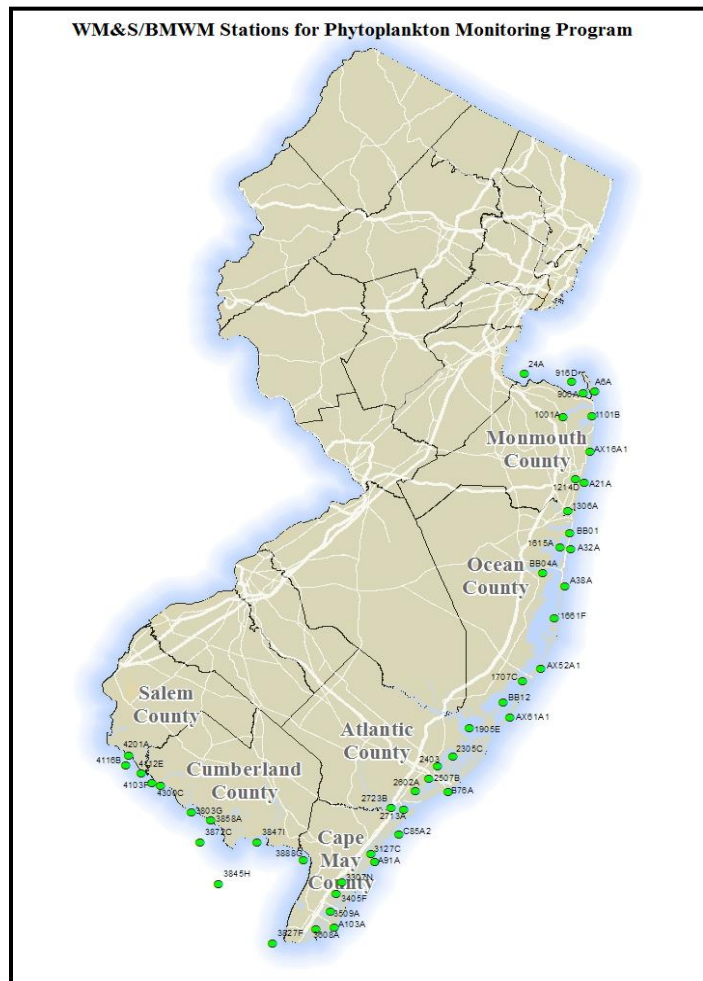
Nutrient Sampling Stations - South Section



Toxic Monitoring

The DWM&S/BMWM collects samples at regular intervals throughout the summer to determine the occurrence of marine algae that produce biotoxins (see figure to the right for the location of the 48 phytoplankton sampling stations in New Jersey). Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption and can adversely affect the respiratory function of people. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water.

Since 2007, algal blooms are also identified by the DWM&S/BMWM with the aid of a remote chlorophyll flight sensor. Coastal monitoring flights with remote aircraft sensing have taken place from Coyle Field in Burlington County, north to the Raritan Bay, south to the Little Egg Harbor Inlet, and back to Coyle Field (short flights), and from Coyle Field, north to the Raritan Bay, south to Cape May Point, west into the Delaware Bay, and north through the back bays of New Jersey back to Coyle Field (long flights). In a partnership between the DWM&S/BMWM, the New Jersey Forest Fire Service (aviation operations and maintenance), Rutgers University (data management), and USEPA Region 2 (funding), these flights (4 short flights and 2 long flights a week) are scheduled for six days a week from May to September of each year. Flight observers are also on these flights to observe conditions that could adversely affect bathing beach and water quality, such as the presence of algal foam from algal blooms, floating trash or debris, broken sewer lines, and the presence or absence of marine life and fish kills. The sensor data from these remote aircraft sensing flights provide estimates of coastal chlorophyll 'a' levels and a perspective on bloom conditions/trends. If estimates of coastal chlorophyll 'a' levels come up high in specific areas during a coastal monitoring flight, this enables the Bureau to target boat sampling to locations where algal blooms might be occurring. The NJDEP and Rutgers University Chlorophyll Remote Sensing flights in the waters of New Jersey are available electronically at: <http://njdep.marine.rutgers.edu/aircraft/>.



Generally, no toxic species associated with large algal blooms over long periods have been recorded for the Delaware Bay Remote Area. The phytoplankton monitoring of sampling stations in New Jersey waters is available electronically at: <http://www.nj.gov/dep/bmw/phytoplankton.htm>.

CONCLUSIONS

Based on the bacteriological data assessed, most of the sampling stations within this growing area meet their current shellfish classifications, except for Sampling Station 4112E in the Delaware Bay – Coastal Stow Creek area. The overall water quality for this growing area is good.

RECOMMENDATIONS

Continue sampling using the existing Adverse Pollution Condition (APC) strategy for Assignments 315, 327, 332, 357, 362, 377, and 378.

It is also recommended that approximately 392.4 acres of *Approved* shellfish waters around sampling station 4112E will need to be downgraded to the *Restricted* shellfish classification. The area to be reclassified is shown in the figure on page 39.

The New Jersey Administrative Code (N.J.A.C. 7:12) Shellfish Water Classification & Special Permit Rules need to be revised to show the change in this shellfish water classification.

LEGAL DESCRIPTION FOR RECOMMENDED CHANGES:

7:12-3.1 Shellfish growing waters that are classification as Restricted

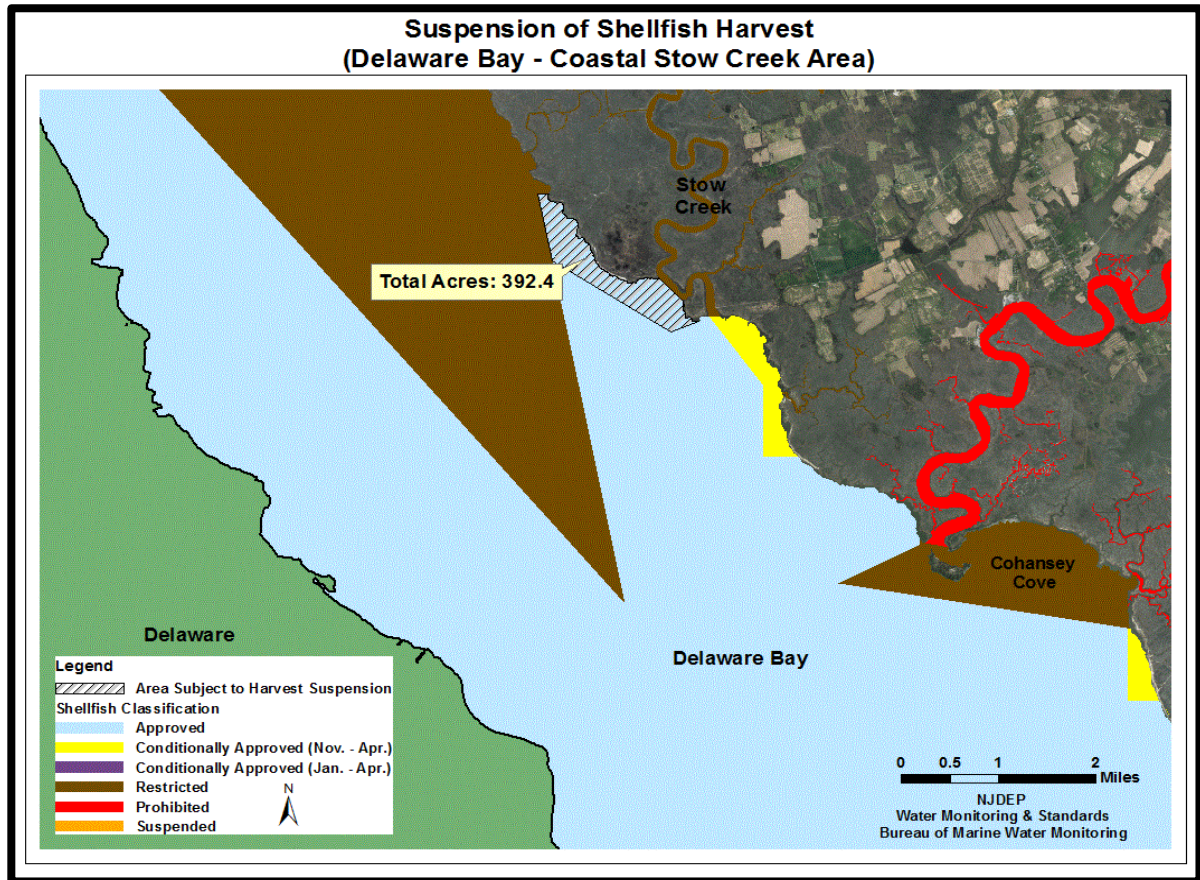
(a) The following shellfish growing waters are classified as Restricted:

32. Delaware Bay area (Note: A portion is also designated as Seasonal. See N.J.A.C. 7:12-4):

xi. No change

xii. All of the waters contained within a line beginning at a point southwest of the mouth of Cherry Tree Creek at latitude 39 degrees 24 minutes 1.00 seconds N, longitude 75 degrees 26 minutes 27.9 seconds W, then bearing east to a point at latitude 39 degrees 24 minutes 1.1 seconds N, longitude 75 degrees 26 minutes 20.3 seconds W, then following the shoreline southeast to a point southwest of the mouth of Stow Creek at latitude 39 degrees 22 minutes 49.71 seconds N, longitude 75 degrees 24 minutes 35.95 seconds W, then bearing approximately 247.8 degrees T to a point at latitude 39 degrees 22 minutes 43.47 seconds N, longitude 75

degrees 24 minutes 55.08 seconds W, then bearing approximately 302.2 degrees T to a point at latitude 39 degrees 23 minutes 22.88 seconds N, longitude 75 degrees 26 minutes 17.42 seconds W, then bearing approximately 349 degrees T back to the point of origin and terminating;



LITERATURE CITED

- APHA. 1970. Recommended Procedures for the Examination of Seawater and Shellfish, 4th ed., American Public Health Association, Washington, DC
- APHA. 1995. Standard Methods for the Examination of Water and Wastewater, 19th ed., American Public Health Association, Washington, DC
- Bochenek, Dr. Eleanor. 2000. "New Jersey's Marine Recreational Fisheries" The Jersey Shoreline: Special Edition 1999-2000. New Jersey Sea Grant College Program and New Jersey Sea Grant Extension Program in cooperation with the New Jersey Marine Sciences Consortium, Fort Hancock, NJ
- Connell, Robert C. 1991. Evaluation of Adverse Pollution Conditions in New Jersey's Coastal Waters. New Jersey Department of Environmental Protection, Marine Water Classification and Analysis, Leeds Point, NJ
- Flimlin, Gef, and Stewart Tweed. 2000. "Commercial Fisheries" The Jersey Shoreline: Special Edition 1999-2000. New Jersey Sea Grant College Program and New Jersey Sea Grant Extension Program in cooperation with the New Jersey Marine Sciences Consortium, Fort Hancock, NJ.
- Gosner, Kenneth L. 1978. The Peterson Field Guide Series: A Field Guide to the Atlantic Seashore. Houghton Mifflin Company, Boston, Mass.
- Guo, Dr. Ximing, and Dr. John Kraeuter. 2000. Aquiculture and Breeding Biotechnology. The Jersey Shoreline: Special Edition 1999-2000. New Jersey Sea Grant College Program and New Jersey Sea Grant Extension Program in cooperation with the New Jersey Marine Sciences Consortium, Fort Hancock, NJ.
- Ingmanson, Dale E., and William J. Wallace. 1989. Oceanography: An Introduction. Wadsworth Publishing Company, Belmont, California.
- Matassino, Joe, et al., editors. 2002. The Delaware Estuary: Join in Its Rediscovery. 2002 State of the Estuary Report. Partnership for the Delaware Estuary, Wilmington, Delaware.
- Morris, Percy A. 1975. The Peterson Field Guide Series: A Field Guide to Shells of the Atlantic. Houghton Mifflin Company, Boston, Mass.
- NJDEP. 2005. Field Sampling Procedures Manual. New Jersey Department of Environmental Protection, Trenton, NJ

NJDEP. 2008. Annual Summary of Phytoplankton Blooms and Related Conditions in New Jersey Coastal Waters. (Summer 2005). New Jersey Department of Environmental Protection, Freshwater and Biological Monitoring, Trenton, NJ.

NJDEP. 2013. 2013 Annual Review of Shellfish Growing Areas for Data Year 2013, Growing Area # DE-1: The Delaware Bay from Maurice River Cove to Artificial Island. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ

NJDEP. 2015. 2015 Annual Review of Shellfish Growing Areas for Data Year 2015, Growing Area # DE-1: The Delaware Bay from Maurice River Cove to Artificial Island. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ

NJDEP, 2015. Techniques and Practices for *Vibrio* Reduction – Use of Shading and Rapid Cooling (ice slurry) to Control *Vibrio* Growth. . New Jersey Department of Environmental Protection, Marine Water Monitoring, Leeds Point, NJ

NJDEP. 2016. 2016 Annual Review of Shellfish Growing Areas for Data Year 2016, Growing Area # DE-1: The Delaware Bay from Maurice River Cove to Artificial Island. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ

NJDEP. 2016. State of New Jersey Shellfish Growing Water Classification Charts. New Jersey Department of Environmental Protection, Marine Water Monitoring, Leeds Point, NJ

NJDEP. 2017. New Jersey Eastern Oyster Direct Market Harvest Landings Totals for the Delaware Bay 2011 – 2016. New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Bureau of Shellfisheries, Millville, NJ

NMFS. 2017. Marine Fisheries Annual Landings Results for New Jersey 2011 – 2016. National Marine Fisheries Service, Fisheries Statistics and Economics Division, Silver Spring, Md.

Shellfish Growing Area Report Guidance Document. 2007. New Jersey Department of Environmental Protection, Marine Water Monitoring, Leeds Point, NJ

The Richard Stockton College of New Jersey. 2002. Common Estuarine Fish of New Jersey. The Richard Stockton College of New Jersey, Marine Science Program, Pomona, NJ

USDI - GS. 1977. Topographic Map of Fortescue, NJ – Del., US Department of the Interior, Geological Survey, Denver, Co.

USDI - GS. 1977. Topographic Map of Heislerville, NJ, US Department of the Interior, Geological Survey, Denver, Co.

USDI - GS. 1977. Topographic Map of Port Norris, NJ, US Department of the Interior, Geological Survey, Denver, Co.

USPHS. 2009 Revision. National Shellfish Sanitation Program (NSSP) *Guide for the Control of Molluscan Shellfish*. US Public Health Service, Food and Drug Administration, Washington, DC

Wesighan, Paul. 2004. Sanitary Survey of Shellfish Growing Area DB1: The Delaware Bay from Maurice River Cove to Artificial Island. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ

Wesighan, Paul. 2013. Reappraisal of Shellfish Growing Area DB1: The Delaware Bay from Maurice River Cove to Artificial Island. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ

U.S. Census Bureau, www.census.gov/

US Geological Survey, www.usgs.gov/

SUPPORTING DOCUMENTATION

A. Statistical Summaries

Year-round/ Summer/ Winter - [rptStatSummary Approved APC.pdf](#),
[rptStatSummary SpecialRestricted APC.pdf](#),
[rptStatSummary Approved APC extended to 2003.pdf](#),
[rptStatSummary SpecialRestricted APC extended to 2003.pdf](#)

B. Seasonal Evaluation - [rptStatSummary Seasonal.pdf](#)

C. Precipitation -

Cumulative Rainfall - [rptStatsSummary Rainfall.pdf](#)

Wet/Dry Weather Statistical Summary –
[rptWetDry 24HrStats.pdf](#), [rptWetDry 48HrStats.pdf](#), [rptWetDry 72HrStats.pdf](#)

D. Data Listings -2005 through 2013 –[rpt_DataListing.pdf](#), [rpt_DataListing_extended_to_2003.pdf](#)

E. Shoreline Survey photographs and sheets- [..\Shoreline Survey DB1-17\Canton Village STP \(April 06, 2017\)](#), [..\Shoreline Survey DB1-17\City of Millville WWTP \(November 22, 2016\)](#), [..\Shoreline Survey DB1-17\Cumberland County UA \(Bridgeton\) WWTP \(February 10, 2017\)](#), [..\Shoreline Survey DB1-17\Hancocks Bridge STP \(April 06,2017\)](#), [..\Shoreline Survey DB1-17\Shoreline Survey of DB1 \(Cohansey River, Cohansey Cove, and up to Oyster Cove\) on June 30, 2016](#), [..\Shoreline Survey DB1-17\Shoreline Survey of DB1 \(Delaware Bay from Stow Creek to Upper Deep Creek\) on May 23, 2017](#), [..\Shoreline Survey DB1-17\Shoreline Survey of DB1 \(East Point and east side of Maurice River\) on January 19, 2017](#),[..\Shoreline Survey DB1-17\Shoreline Survey of DB1 on February 14, 2017 by Dominick](#),[..\Shoreline Survey DB1-17\Shoreline Survey of DB1 on February 15, 2017 by Dominick](#), [..\Shoreline Survey DB1-](#)

[17\Shoreline Survey of DB1 on February 21, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on February 22, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on February 23, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on February 28, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on February 7 and 8, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on January 10, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on January 11, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on January 19, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on January 23, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on January 24, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on January 31, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on March 15, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on March 21, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on March 22, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on March 29, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on March 7, 2017 by Dominick, ..\Shoreline Survey DB1-](#)
[17\Shoreline Survey of DB1 on March 8, 2017 by Dominick.](#)